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Weigh All Charges Before the Heat

Confusion Avoided By Having the Coke and Metal Ready to Charge Into the Cupola Before the Blast is Put On—Scrap and Coke Are Dumped Automatically

BY H. E. DILLER

SOME take a chance and win. Others who are eminently successful are noted for conservatism and always observe every precaution to insure exact control of their business. As these two diametrically opposite methods win success at times, it can not be that both methods are always right, but circumstances must govern. In the foundry making fairly heavy castings which do not require much machine work or are not put under undue strains, it would be unprofitable to go to great lengths to keep the metalloids in the iron close to any fixed standard. Here cars of pig iron, which approximate the same composition by the furnace analysis, may be unloaded by a magnet and dropped on the same pile and thus cut the expense of handling. However, in many shops where castings are made which require a definite composition of metal, care must be exercised to get the right iron in every charge. In this case each car of metal should be piled separately and the charge cal-

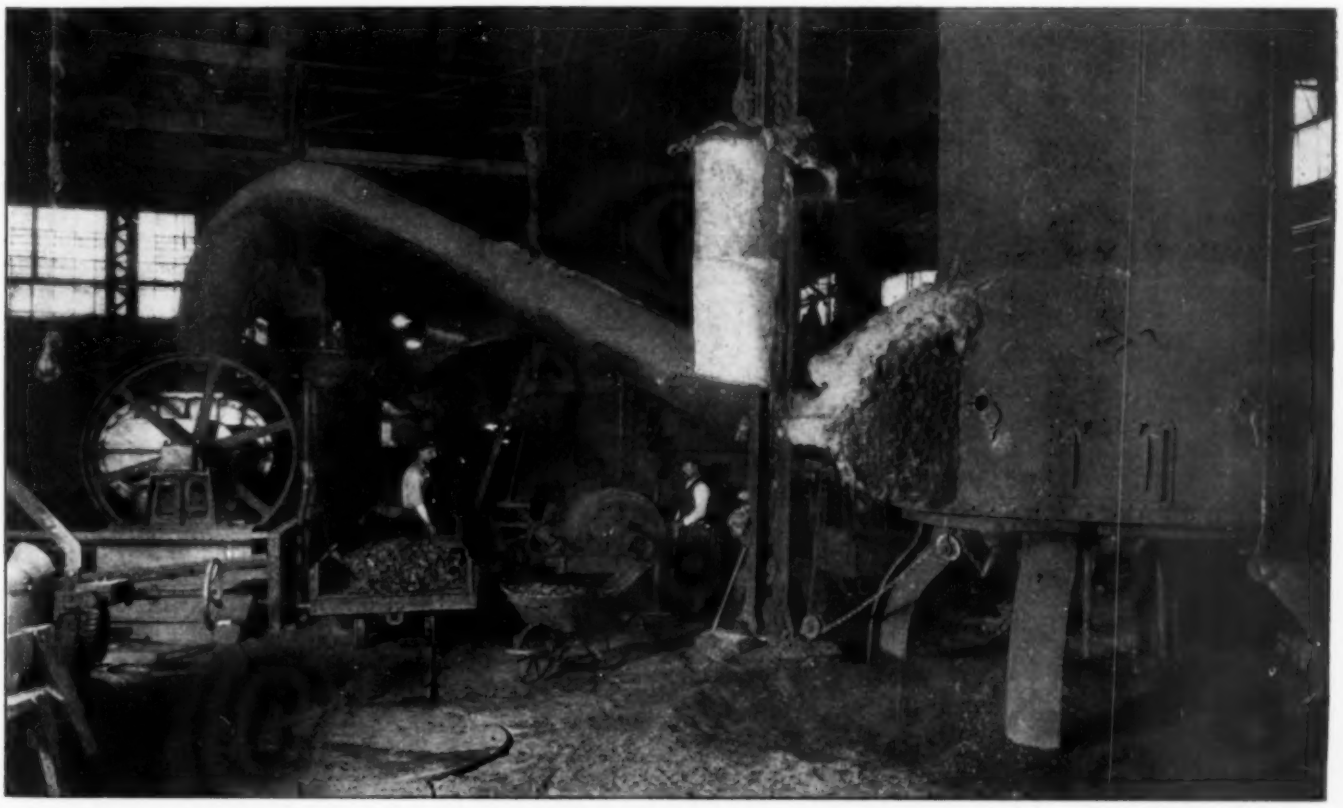

FIG. 1—A POSITIVE-PRESSURE BLOWER LOCATED ON THE FOUNDRY FLOOR FURNISHES BLAST FOR THE CUPOLAS—THE REFUSE FROM THE DROP IS TUMBLED IN THE MILL AT THE CENTER OF THE ILLUSTRATION TO RECLAIM THE METAL

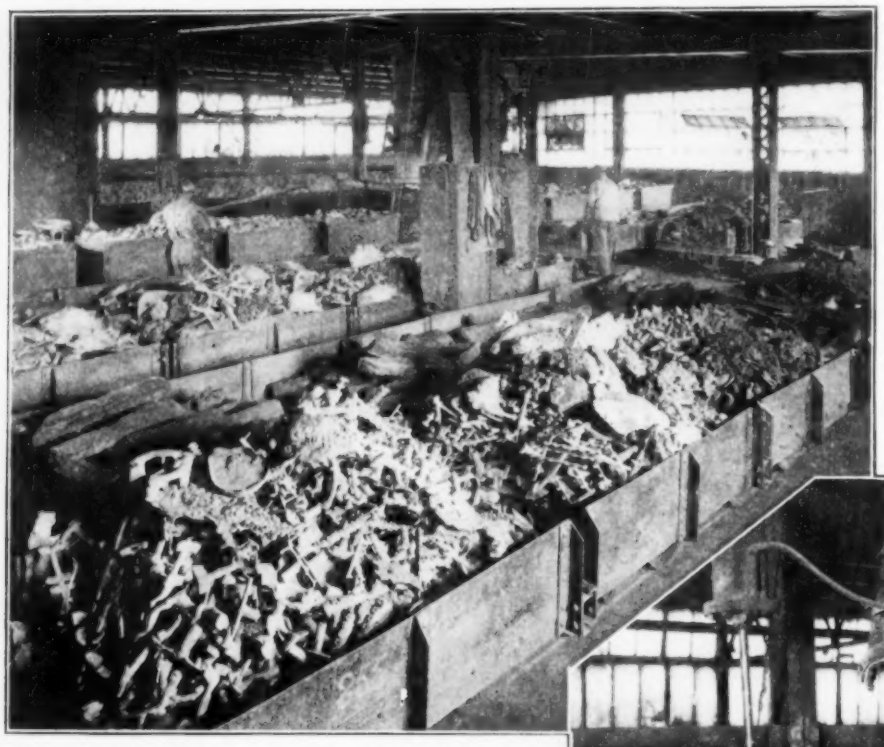

FIG. 2—ALL COKE, PIG IRON AND SCRAP IS WEIGHED ON CARS AND BROUGHT TO THE CHARGING PLATFORM BEFORE THE HEAT IS STARTED

culated by the analysis of each carload of iron put into it.

Every precaution is used at the plant of the Taylor & Boggis Foundry Co., Cleveland, manufacturer of a variety of castings including parts for locks which are quite small and demand soft but strong metal. In addition to piling each car of pig iron separately, the company has installed a cupola charging mechanism which assists in insuring that the right metal goes into each charge. The feature which primarily affords this safeguard is the ability to weigh the charges deliberately and with care. Pig iron, scrap and coke are weighed during the day in cars which are placed on the charging platform before charging is commenced. In this way there never is any rush to get iron to the cupola and confusion in weighing is avoided.

Pig iron, scrap, or coke are piled on a car in the stock yard and the car is taken to a scales in front of one of the two elevators, as shown in Fig. 3. A pile of scrap and piles of the different pig iron used are kept

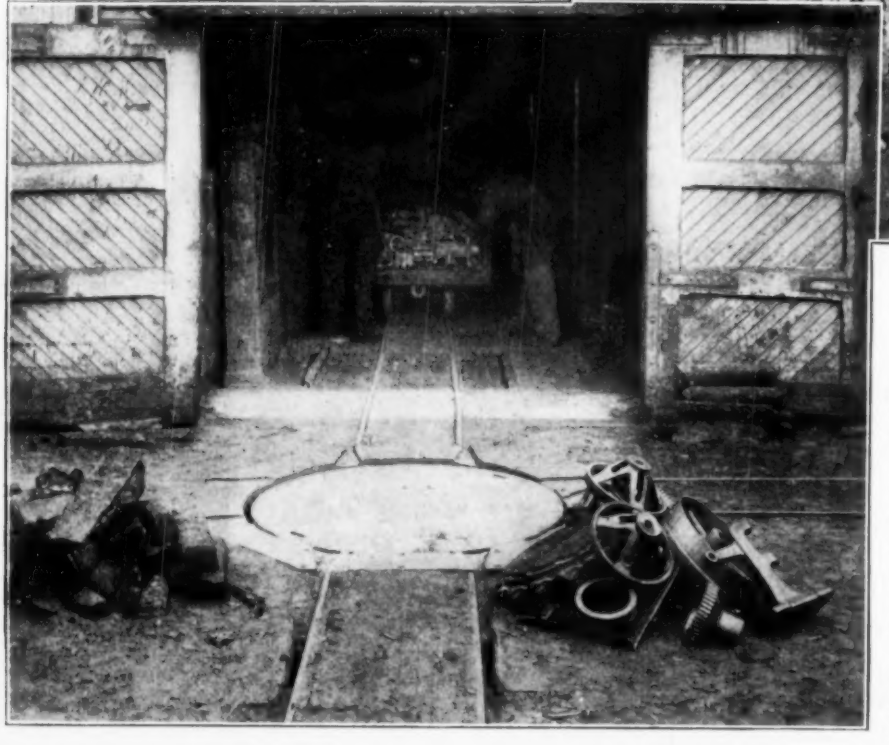

FIG. 3—A CHARGING SCALE IS LOCATED NEAR THE ELEVATOR

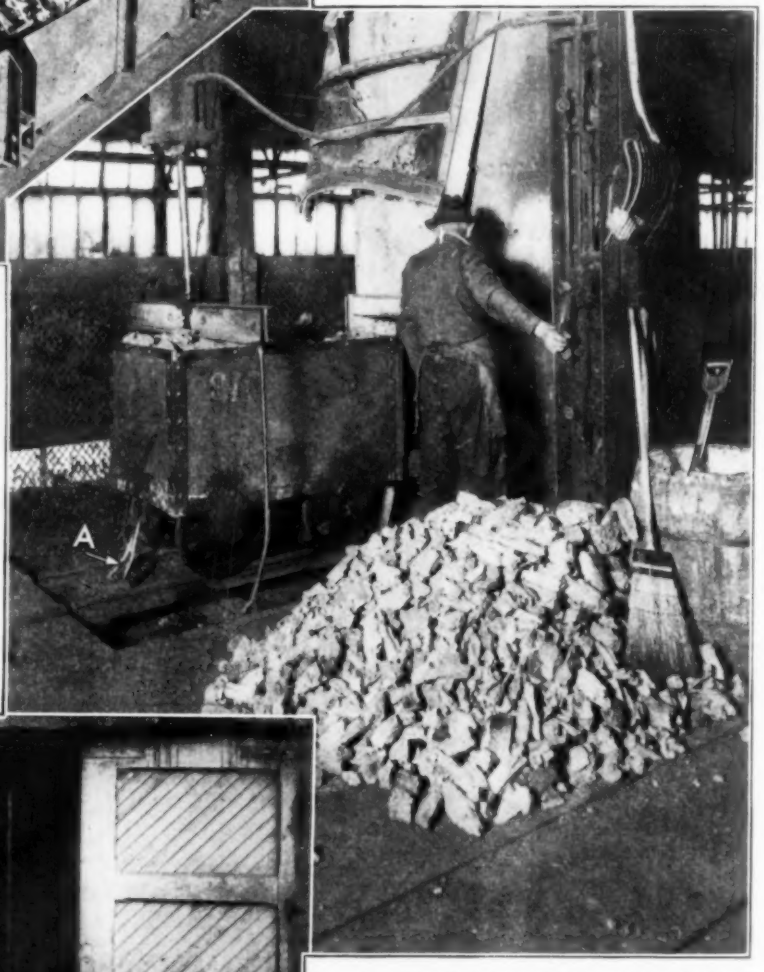

FIG. 4—COKE AND SCRAP ARE DUMPED AUTOMATICALLY INTO THE CUPOLA, BUT PIG IRON IS CHARGED BY HAND TO LEVEL THE CHARGE

just outside the building near the scales. When the loaded truck is weighed, iron is taken off if there is too much, or if the load is light more iron from the small lots at hand is added. In this way the correct amount can be sent to the charging floor on each truck. Two elevators were installed so that one always is in use and no delays are experienced.

After the loaded trucks reach the charging platform they are pushed along on a transfer car and stored on any one of eight tracks which run across the platform. The rails con-

sist of ¾ x 2½-inch steel bars which are bolted to the steel plates forming the floor of the platform. The charging floor filled with loaded trucks may be seen in Fig. 2. As may be noted in this illustration there are two cupolas. The one is 60 inches inside diameter and the other is a larger unit, being 84 inches within the lining. A transfer track from each of the elevators leads to a cupola. The larger one is used almost exclusively and the small cupola is held for emergency. As the smaller cupola is not used often it was decided not to go to the expense of installing a car-dumping equipment for it. However, cars are tilted for dumping their load into the large cupola by the device illustrated in Fig. 4. This consists of a hinged platform to which cars are brought on the transfer car. The rear of the car is hooked to the platform by a catch, *A*, Fig. 4, to prevent it from falling into the cupola. The platform is raised on a hinge next to the cupola by a pneumatic cylinder to which it is attached by a yoke. Control of the hoisting apparatus is secured through a valve at the side of the cupola. In charging, the operator stands as in the illustration, with his right hand on the control lever and facing the door so as to note the way the charge falls. Coke is loaded on cars with one end hinged at the top and held with a latch. This end plate opens and allows the coke to fall when the car is tilted towards the cupola. Pig iron and scrap are piled on separate cars. As the charges of metal in the cupola are each two tons, except the first charge which is three tons, and as each charge contains 50 per cent scrap and 50 per cent pig iron, a carload of each is added to make up a charge. The scrap is dumped like the coke, but the pig iron is hand charged, for it is thought that the charge in the cupola can be leveled better by placing the pigs in particular places. Because the sprue and scrap from the foundry does not amount to 50 per cent of the charge it is necessary to purchase some foreign scrap to make the mixture as desired. This scrap is carefully selected and is so proportioned with the home scrap that an excessive amount is not put on any one charge.

The molten metal is caught in tilting buggy ladles which are transported through the foundry on industrial tracks. Then the metal is caught in hand ladles at different stations for pouring. A view of the rear of the cupolas, Fig. 1, shows the positive-pressure blower which furnishes air to both furnaces. The pipe curving from the blower to one of the cupolas may be seen. The large white object in the center of the illustration is a hood which is dropped back of the slag hole during the heat to prevent slag blowing against passing workmen. The refuse from the cupola drop is tumbled in the barrel shown in the center of Fig. 1. The iron is reclaimed and the slag and cinder removed to the dump.

Adopt Safety Devices for Foundry Crane

BY NICHOLAS PRAKREN

PRESENT methods of production demand the electric crane of some design in nearly every shop. There are as many different types of cranes and hoists today as the kinds of service that demands them, but this paper is confined to the class of cranes that are used in the foundries, machine shops, yards, shipways and warehouses.

The standard electric overhead traveling crane is built of three units; bridge, trolley and cage. The bridge is composed of truck ends, girders, bridge machinery, foot walks and electrical equipment. The safety features that safeguard the workmen are naturally a part of the design. The first essential is liberal strength in the properly proportioned parts of every unit piece in the crane.

The safety features in the foot walk are good strong angle iron hand rails, and the solid floor boards which are extended to girder, with a 6-inch angle iron bordering the foot walk so no tools or parts can be kicked off. Often foot walks are provided on both girders of the crane. This is advisable but not necessary unless the trolley is of such a design that an extra foot walk is imperative.

The component parts of the trolley are: Trolley sides, girts, gears and gear cases, drums and electrical equipment. The greatest safety feature on the trolley is the totally enclosed gears and the limit switch. The safest type of upper limit switch is the one that opens the hoisting motor circuit through a relay. This switch consists of a weight, a cable, a weighted sheave and a connection box. An insulated arm that closes the relay circuit by the weight attached to the cable is mounted on the weighted sheave shaft. One of the hoisting cables passes through a loop fastened to the suspended weight. Irrespective of the swinging of the load, the load block in its upper travel, will carry the suspended weight upward allowing the weighted sheave to open the relay circuit, thus opening the motor circuit and bring the motor to rest.

The cage contains the controllers, grids, switchboard and foot levers to stop the bridge. A new safe location has been found for the grid resistances which are mounted on a subfloor underneath the floor of the cage. The floor of the cage is provided with trap doors so the grid units can be inspected. The switchboard is located at the back of the cage in a closed cabinet. The doors can be opened for inspection or repairs and by virtue of the enclosure no casualties can arise.

Many different methods are used to keep the crane out of service during repairs. Often one or more maintenance men are busy repairing different parts of the crane. One side of the main line circuit has three sockets with plugs. To complete the circuit all three plugs must be in. Three of the repairmen working on the crane each keeps a plug in his pocket until his task is completed. When all three repairmen have finished, the three plugs will be in their respective sockets.

Another method is to place the main-line switch in a box and keep it locked. In case of a temporary breakdown the maintenance man unlocks the main line switch cabinet, opens the switch, and again locks the cabinet. As soon as the repairs have been made the cabinet is unlocked, switch closed and the cabinet locked again. The crane is then ready for operation.

Ease with which repairmen are enabled to move about the crane is another item of safety. The ladder reaching from the cage to the foot walk should be so located that the floor of the cage is always beneath the repairman. This is not always possible where building clearance demands a limited space for a cage.

Abstracts from a paper read at the Milwaukee meeting of the National Safety council, Sept. 30, 1920, by Nicholas Prakken, Pawling & Harnischfeger, Milwaukee.

The New York district office of the Air Reduction Sales Co. after May 1 will be located at the factory, 191 Pacific avenue, Jersey City, N. J. All correspondence and other communications heretofore directed to the district office at 160 Fifth avenue, New York, should be sent to the Jersey City address.

Reactions in the Basic Open Hearth

History of a Heat Showing the Chemical and Thermal Actions Which Take Place—Correct Melting Practice Aid To Eliminate Slag Inclusions—Manganese Kept High in Charge

BY C. W. VEACH

MANY steelmakers claim that a better grade of steel can be made in acid open-hearth furnaces than in basic open hearths. This perhaps is true where the basic steelmakers aim to produce the greatest possible tonnage with a corresponding disregard for quality.

The writer believes that three-fifths of the steel made in the basic furnaces of this country does not have enough personal detailed supervision by the melter while the metal is being refined. To a certain extent the basic furnace is considered a scavenger and not enough care is taken in selecting the raw material. With proper regard for quality in selecting pig iron, scrap and limestone; melting in a sharp working furnace, having a bottom made of the best material; using recording gages for air, oil and draft; and enforcing the general rule for operating the furnace and for reversal of the flame, a quality of steel can be made which will compare favorably with that of the acid open-hearth furnace.

Need Care in Steelmaking

It is true that extensive tests have indicated that basic steel contains more oxides than acid steel, but, is this inherently the case? Is it not rather a manifestation of indifference on the part of the basic steel producer?

In the steel foundry of the Bettendorf Co., Bettendorf, Iowa, basic open-hearth steel is being produced which shows a minimum of oxides under a magnification of 200 diameters. The steelmaker is handicapped by a shallow bath which entails the greatest care during the refining period to prevent over-oxidation. The bottom is an important factor in making good steel; excessive scorification makes a slag high in magnesium oxide which is not desirable. Too often in foundry practice, the scrap produced is returned to the furnaces for recharging without being properly cleaned. This not only affects the heat in which it is charged but also weakens the bottom for subsequent use as the effect of silica sand on a magnesite bottom is bad at high temperatures.

Too little credence perhaps is given to the value of manganese in melting and refining a bath of steel. It is desirable in a combined state as in this form its oxidation is prolonged and is more effective. The residual manganese in the bath, when the metal is all melted, should not be less than 0.30 per cent and with this manganese content not much chance of over-oxidation of the molten material exists. It is poor practice to permit carbon to run below the desired point before tapping with the view of raising it in the ladle. The addition of coal to molten steel forms gases which remain in the steel. The average steelmaker admits there is a wide variation from day to day in the carbon content of the heats when melted. Because of this lack of uniformity the skill of the melter is taxed to produce a uniform finished product. In some cases, the furnace operator is left to get the heat ready to tap without any assistance whatsoever from the melter, this being especially true if the operator is experienced enough to be depended upon this far. This is poor practice because detrimental reactions may occur which are not recognized by the helper, or, if recognized, are not corrected because all he is interested in is to get the desired carbon and temperature.

Oil is a desirable fuel and although high in price, if used correctly, the cost per ton of steel produced need not exceed that of steel produced with less expensive fuel. While sufficient atomizing pressure should be maintained to insure complete combustion, an oxidizing flame should be avoided. A careful examination of flue gases aids in determining the air or steam pressure to be used.

Table I shows the history of a heat poured in 1914 when a campaign for a higher quality of steel was begun by the writer. This data is on a 25-ton basic open-hearth furnace charged with 40 per cent pig iron and 60 per cent scrap, and the necessary limestone to form the slag. A slag test was taken with each steel test, the data in Table II being obtained.

The heat represented here is typical of the old rule-of-thumb practice and shows that the result is anything but desirable. However the steel from this heat met all chemical and physical specifications. A better grade of steel is now being made in the same furnace under the new practice.

The claim is made that the difference in quality between acid, and basic steel is due to slag inclusions in the basic steel. This fact, if it exists, can be overcome by keeping the bottom in good condition, thus preventing puddle holes; charging with clean scrap and pig iron low in silicon content; keeping the tap hole small, firm and low in relation to the bottom; using 3 pounds of ferrotitanium per ton of metal charged, added to the ladle when tapping; and allowing the ladle to stand after tapping to give the titanium time to function.

Titanium is not a cure by any means and will not make a good heat of a bad one. Its effect is not discernible except by the microscope but its value in reducing silicates and further purifying steel is well founded.

Overcoming Slag Inclusions

The theory has been advanced that the *wild* or *blow* metal lying directly under the slag is caused by reaction between calcium oxide in the slag and silicon in the steel. This theory has been refuted before and merits no more discussion. The actual conditions are shown by the accompanying illustration.

After the steel was out of the furnace and had time to settle a sample was drawn by introducing the sampling ladle through the slag, care being taken to reach just deep enough in the steel to fill the ladle. After the first mold was poured another sample was taken. The succeeding samples were taken as indicated in the drawing. The result shows the same silicon content in the sample taken from the top of the ladle before pouring as in the sample taken when pouring is about finished. It will be noted that the silicon is lower below line No. 1 than from lines Nos. 1 to 3. This is so because the silicon is added between these two lines. Also there is a gradual decrease of silicon above line No. 3. This is attributed to the discontinued whirling motion of the steel and the presence of slag. Therefore, it is essential that a portion of the ferrosilicon remains on top of the metal

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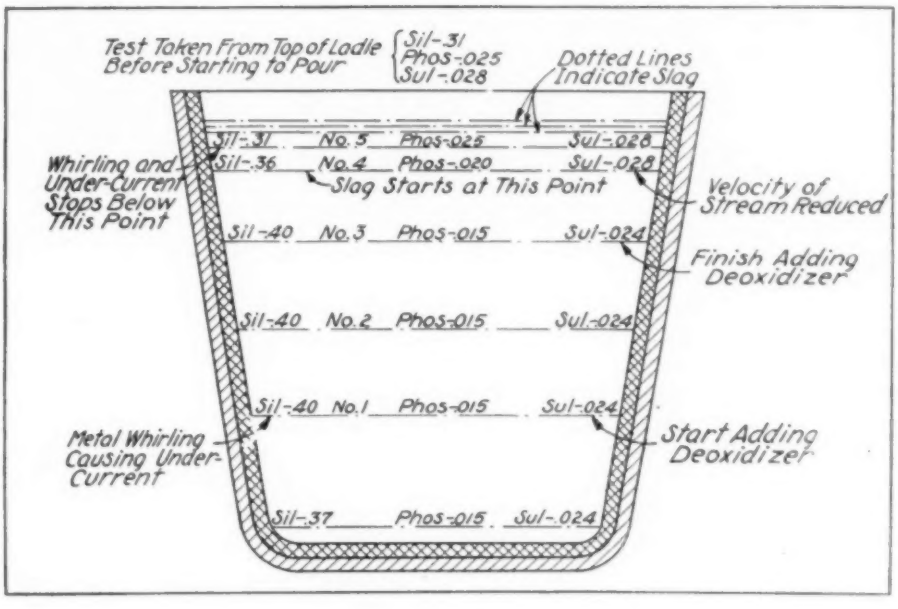

Test Taken From Top of Ladle Before Starting to Pour
Sil-.31
Phos-.025
Sul-.028
Dotted Lines Indicate Slag
Sil-.31 No. 5 Phos-.025 Sul-.028
Whirling and Under-Current Stops Below This Point
Sil-.36 No. 4 Phos-.020 Sul-.028
Slag Starts at This Point
Velocity of Stream Reduced
Sil-.40 No. 3 Phos-.015 Sul-.024
Finish Adding Deoxidizer
Sil-.40 No. 2 Phos-.015 Sul-.024
Sil-.40 No. 1 Phos-.015 Sul-.024
Metal Whirling Causing Under-Current
Start Adding Deoxidizer
Sil-.37 Phos-.015 Sul-.024

until the slag begins to flow. The speed at which the stock is added must be governed by the flow of the metal into the ladle.

It will be interesting to follow the changes which take place during a heat. These changes with the absorption of heat by the charge require time. The time required for a 25-ton heat may be outlined as follows: Charging, 2 hours; melting, 3 hours, refining 2 hours. But if tonnage is desired above quality, the time can be divided into: Charging, 2 hours; melting 2½ hours; refining, 1½ hours.

More Time Needed

The object for a longer time may be defined as follows. After the lime begins to rise to the surface, the flame temperature is reduced to prevent slag and metal from becoming too hot before enough slag is formed to take up the P_2O_5 which at this stage should be at the surface of the bath. This increase in slag weight is produced by the solution of some lime with the liquid slag which is chiefly the product of oxidation. After fusion is complete and the lime has all come up, the slag will be increased in volume and will hold a large proportion of the lime in a lumpy state. While the flame is playing upon this inactive mass, the bath is protected and will lose by flotation much of its occluded gases and slag inclusions. At the same time, the slag is adjusting itself to a condition which gives the carbon access to FeO which the slag has carried to the surface.

The stock from which the charge is selected should be classified according to its chemical composition. This classification should include the pig iron and the scrap. With a knowledge of the approximate analysis of the different sections or piles of material, the proportion of each entering the heat can be determined and a uniform charge made up. Also a formula can be drawn up by which the stock foreman is guided. Suppose that Section *A* contains pig iron having: manganese, 2 per cent; silicon, 1.10 per cent; and sulphur, 0.035 per cent, and that Section *B* contains pig iron having: manganese, 1.50 per cent; silicon, 0.70 per cent; sulphur, 0.050 per cent. The proportions drawn from each section would be regulated by the composition of contents of each section. The aim would be to arrive at the maximum manganese and minimum silicon and sulphur.

Gray or malleable iron scrap is undesirable because of its high sulphur. Also, if it is mixed with steel scrap, irregular percentages of carbon will be obtained and this may interfere with the melter's schedule.

The impurities in pig iron play an important part in melting and refining a charge. Their relative importance is denoted as follows: carbon, manganese, silicon, phosphorus, and sulphur. The part each one plays while melting and refining a heat will be considered briefly, and thermal values will also be defined.

For a heat of basic open-hearth steel rails or springs first are charged on the bottom and brought to a white heat. These are followed by the limestone which is heated for about 20 minutes in which time about 30 per cent of the decomposition of $CaCO_3$ should be accomplished. The scrap and pig iron are now charged and another reaction soon takes place. As soon as the scrap gets red hot, the formation of iron oxide begins. This continues so long as the low carbon stock is exposed to the flame and is the chief source of supply of oxygen for the subsequent oxidation of almost all the impurities of the bath. Normally carbon is not oxidized to any great extent during melting if the limestone was heated thoroughly before charging the scrap and pig iron.

Not every one is familiar with the chemical reactions which occur in a bath of metal in the basic open-hearth furnace, and the important influence they have on the attainment of quality in the finished product. The constituents will be considered in the sequence of their importance: Manganese, silicon, phosphorus, and sulphur. Carbon is purposely omitted in this list and will be dealt with last.

Oxidation of Manganese

The manganese should not be under 1.25 per cent of the total charge; this would require more than 2 per cent manganese in the pig iron. As the heat melts down level, a slag is formed whose chief constituents are the products of oxidation. While acid in nature at first, this slag is important in so far that it protects the metal from the action of the flame

Composition of Liquid Steel at Various Depths in the Ladle

Table I

History of Heat of Basic Open-Hearth Steel

Test No.		C	Si	P	S	Mn
1	After fusion	.51	.030	.005	.020	.24
2	20 minutes later after adding 300 pounds iron ore	.42	.025	.005	.022	.27
3	15 minutes later after adding 30 pounds fluor spar	.31	.015	.005	.017	.26
4	15 minutes later—ladle called	.23	.015	.005	.017	.25
5	Taken at tapping—25 pounds coal added to ladle	.16	.015	.005	.015	.28
6	Taken from ladle at start of pouring	.21	.32	.015	.019	.63
7	Taken near finish of pouring	.21	.30	.019	.019	.59

Table II

Result of Slag Tests of Basic Steel

Test No.	1	2	3	4	5	6	7
$Si\ O_2$	10.38	11.82	12.18	12.22	10.66	8.96	28.80
$Fe\ O$	27.00	26.02	25.12	25.03	26.76	48.86	17.09
$Al_2\ O_3$	0.90	0.88	0.85	0.92	0.92	0.93	5.23
$Ca\ O$	48.03	46.42	46.07	46.86	46.24	26.89	36.83
$Mg\ O$	9.57	9.36	9.06	8.38	8.32	9.24	8.62
$P_2\ O_5$	1.78	1.69	1.37	1.32	1.19	0.88	0.73
$Mn\ O$	6.33	7.57	7.57	7.02	6.62	4.41	6.49

Note: Test No. 6 was taken from the top of the ladle; No. 7 was taken after finishing pouring.

and retards the formation of FeO to a great extent. The bath is now saturated with FeO and as melting proceeds and manganese is liberated from its solid solution with pig iron, the manganese attacks the FeO forming MnO.

$$FeO+Mn=MnO+Fe$$

In this reaction there is a net gain in temperature because in breaking up the FeO 65,700 calories of heat are absorbed and the formation of MnO evolves 90,900 calories, this leaves a gain of 90,900—65,700=25,200 calories.

The manganese also forms manganese sulphide, MnS, and rises to the surface where it obtains oxygen from the flame and the sulphur, to a small extent, is oxidized to SO_2 and passes off the waste gases. Some lime will have come to the surface at this stage and the manganese, liberated when SO_2 is formed, will act to make the lime more fluid giving it the quality of entering in solution and forming calcium sulphide, CaS, which is formed by the following reaction:

$$FeS+CaO+C=CaS+Fe+CO$$

If the percentage of manganese is kept high, iron sulphide will be broken up and MnS will be formed instead.

$$FeS+Mn=MnS+Fe$$

When the metal is all melted and the lime has all come up, the oxidation of manganese is complete. That is, in good practice and under normal conditions where no delays have been incurred, the iron oxide—contained in the bath from oxidation of iron while charging, from rust on the charge, and formed by the CO_2 from limestone—has been sufficient to oxidize the manganese, silicon, and phosphorus leaving the residual manganese in the bath 0.30 per cent or more and the carbon about 0.85 per cent. The bath will be free from any harmful amount of FeO.

Oxidation of Silicon

Silicon has an opposite effect from manganese in the elimination of sulphur. It is also doubtful if its deoxidizing effect on the bath is sufficient to compensate for the erosion of the bottom by its oxide, SiO_2. The reaction by which silicon is oxidized to produce SiO_2 has a beneficial effect on the bath in so far as it removes oxygen by the following reaction:

$$2FeO+Si=SiO_2+2Fe$$

and confers some heat to the bath.

SiO_2 FeO
180,000—65,700=114,300 calories evolved.

The careful melter will insist that the silicon content be kept low and that the charge be free from adhering sand—SiO_2—since SiO_2 scorifies the bottom at the slag line, increasing the cost of repair, and is detrimental to the slag when above certain limits.

Phosphorus above limited amounts is not desirable in steel. However, it is of more concern to the manufacturer than to the consumer of basic open-hearth steel castings because the specified maximum for phosphorus content is far above that contained in basic steel. In good practice the phosphorus will not exceed 0.015 per cent. Phosphorus has a high affinity for oxygen forming P_2O_5. If the oxygen is obtained from Fe_2O_3 the reaction is as follows:

$$6P+5Fe_2O_3=10Fe+3P_2O_5$$

In the reaction 117,900 calories are evolved.

A thin open slag and the high temperature which thin slags permits preclude the elimination of phosphorus from a bath of molten metal. Then if the charge is made of material free from adhering sand and if the limestone is of the proper composition and weight, the slag will automatically control the temperature of the bath, because if a sufficiently hot flame is maintained to raise the temperature of the bath before the slag is adjusted to a condition where it will readily conduct the heat, the furnace roof and walls will be burned. So the operator soon learns to reduce the flame temperature as the lime comes up.

Oxidation of Carbon

After fusion is complete and the slag has had 20 to 30 minutes in which to adjust itself under a moderate flame, the operator draws a bath test which is quenched in water and broken. The fracture indicates the amount of carbon, and if this is high and it is desired to hasten its oxidation, iron ore is added and the following reaction

$$3C+Fe_2O_3=2Fe+3CO$$

This reaction absorbs 108,120 calories which must be supplied by the flame. The flame volume during the period in which carbon is oxidized should be sufficient to promote the reaction and to insure no loss of temperature by the bath.

Oreing will be discontinued while there is still some carbon in excess of the amount desired in the bath at tapping. This will be slowly oxidized while the bath is being brought up to tapping temperature and the slag is receiving its finishing touch. If oreing is carried too far, which sometimes occurs, a liberal addition of spiegeleisen will assist in rectifying the mistake and no serious damage will be done. An addition of pig iron containing 13 per cent silicon will also aid in removing the excess Fe_2O_3 and in giving heat to the bath.

Normally as the heat is finally prepared for tapping, the bath will be practically free from iron oxide. This is indicated by the rate at which carbon is being oxidized. About 10 minutes before tapping, manganese in form of spiegeleisen is added. This partially deoxidizes the bath and holds it at rest until the metal is tapped into the ladle. There it is entirely killed by the addition of ferrosilicon containing 50 per cent silicon; ferromanganese containing 80 per cent manganese, and ferro-carbon-titanium containing 15 per cent titanium.

In the parlance of the shop, a *rotten* heat may be made to pass inspection by its treatment when being tapped; but more often a first class heat is rendered second class by the conditions under which it is tapped and treated in the ladle.

Electrochemical Society Has New Section

Corrosion of various metals and alloys under different conditions and the means for combatting such corrosion featured the thirty-ninth general meeting of the American Electrochemical society at Atlantic City during the week of April 18. More than 30 papers were presented, covering a wide range of subjects. About 175 engineers and metallurgists attended the meeting.

An important development of the convention was the decision by the American Electrochemical society to absorb the Electric Furnace association. The society henceforth will have an electric furnace section, which will be the first of several sections into which the society will be divided. Acheson Smith, of the Acheson Graphite Co., Niagara Falls, N. Y., who has been president of the Electric Furnace association during the past year, was chosen president of the electrochemists' organization, succeeding Walter S. Landis.

Other sections also are planned and the constitution and by-laws of the organization will be amended to provide for these sections and to more clearly define the objects of the society with particular reference to the electrothermic field, including heat treating. Formation of an electro-deposition section was proposed, to include electroplating, electrotyping and similar branches. A committee, headed by William Blum, was chosen to investigate this subject.

It was announced that a symposium on electric furnace cast iron will be included in the program for the spring meeting of 1922. The meeting of the autumn of 1921 will be held at Lake Placid, N. Y., beginning probably Sept. 30.

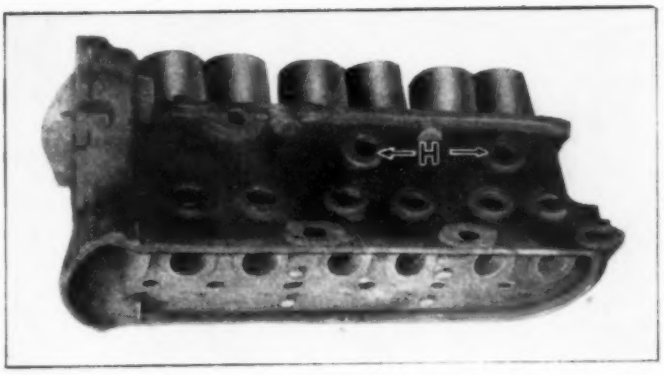


FIG. 1—IT WILL BE SEEN THAT EUROPEAN CYLINDERS DIFFER WIDELY FROM THOSE KNOWN IN AMERICA

Molding Cylinders in an Austrian Shop

BY CHARLES IRRESBERGER

THE shapes of many European motor car cylinders differ in important respects from those cast in the United States. In America the cylinder and cylinder head are molded and cast separately and bolted together after they have been machined. In many continental European plants the two parts are made as one casting, a feature which adds greatly to the difficulty of making the job and one which calls for the highest degree of technical skill on the part of the men engaged in the production of these castings.

Another radical point of difference between the practice pursued in the two countries is that while the usual American practice is to cast the cylinder with the barrels in a horizontal position, the practice in many European plants is to cast them vertically. The following text and illustrations will serve to explain the methods in vogue in a large foundry in Salzburg, Austria.

The company which is equipped to manufacture all the parts entering into the construction of a motor-car in its own shops, now has an output of 200 cars a day. The plant comprises a steel shop, a forge and press shop, a carriage body shop, a ball bearing factory and an assembling shop besides a gray iron and nonferrous foundry for making all castings required. As the company specializes in one make of car, methods have been worked out for standardized production. This is well illustrated in the cylinders where the different operations incident to a complete mold are divided among a great number of men.

Standardized and interchangeable flasks, jigs, patterns and cores render it possible to prepare the component parts of the mold at numerous points on the foundry floor and then assemble them on a given area set apart for that purpose. It will be noted that the molds for these cylinders are made in three-part flasks as compared with the usual 2-part flasks commonly used in the United States.

The bottom and side of one of these Alpine cylinders are shown at the top of the page, while a longitudinal and two cross sections are shown in Fig. 2, 3, 4, and 5.

A sectional view of the three divisions of the pattern in relation to the parting lines on the flask is shown in Fig. 6. It will be noted that the parting line *ab* on the pattern does not correspond with the parting line between the cope and cheek of the flask. A clearer understanding of the pattern construction may be secured by observing the illustrations 12 and 13. From these it will be seen that the bulk of the pattern (patts. 2 and 3 Fig. 12) is molded in the cheek; the barrels (patt. 1 Fig. 12) are molded in the cope and the drag print, (print 1 Fig. 12) which is relatively shallow, is molded in the drag.

The three patterns mounted on their respective plates *X*, *Y* and *Z* are shown in Fig. 13. However, this arrangement has been modified since this photograph was taken. The patterns and plates *X* and *Y* still are in use but the plate *Z* has been discarded. It has been replaced by an iron frame shown in Fig. 7 which serves as a permanent drag and does away with the necessity of ramming a sand drag for each mold. The cores are assembled on the iron drag after which the cheek and cope are set. The lower half of the mold is made entirely in cores so that the iron drag forms a more satisfactory foundation and core seat than one made of sand.

The first molds were made by attaching the whole pattern to a bottom board and ramming the whole flask as a unit, but shortly afterward the present system was adopted. Each part of the pattern was mounted separately so that several groups of molders could work with only one set of patterns. The drag is shown in Fig. 7 while Figs. 8, 9, 10 and 11 represent longitudinal and transverse sections through boards *X* and *Y* with the flasks and patterns in place. A reproduction of the under surface of a cope taken off from the molding plate is shown in Fig. 31.

It will be apparent by referring to several of the illustrations that the

The Cupola Mystery

THE diameter of the cupola given in this article, 25 inches will be questioned by the average American foundryman, accustomed to using a much larger cupola for melting a similar tonnage. Two explanations may be offered. The first is that the writer of the article inadvertently submitted the wrong figures and the second hinges on the fact that many European cupolas are sharply contracted immediately below the tuyeres. The diameter taken at this point is misleading, inasmuch as the melting zone in a cupola commences at a point at least 6 inches above the tuyeres.

While it is true that many American cupolas are bridged out over the tuyeres to a slight extent still the diameter always is taken at the melting zone when computing the melting ratio or any other feature incident to operating conditions.

If the figures given as 25 inches are correct and if the lining in the cupola is straight, the performance is ahead of anything on this side of the ocean. It is claimed that 200 cylinders are cast daily. At a conservative estimate each cylinder will weigh 150 pounds, making a total of 30,000 pounds. The amount of iron required for casting accessory parts will weigh at least as much more; therefore it is evident that at least 60,000 pounds of iron are melted daily.

A 25-inch cupola melting 5000 pounds of iron an hour is considered extremely efficient and such a cupola would have to remain in blast for 12 hours to melt 60,000 pounds. It is highly improbable that the cupola in question is operated daily for that length of time.

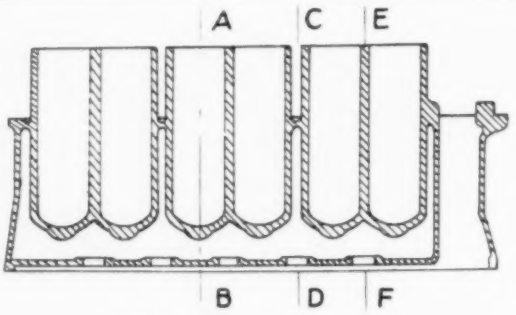


Fig. 2

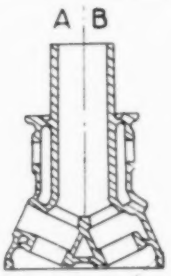


Fig. 3

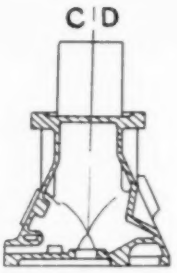


Fig. 4

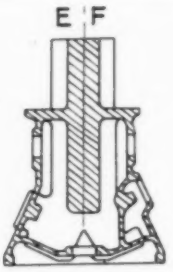


Fig. 5

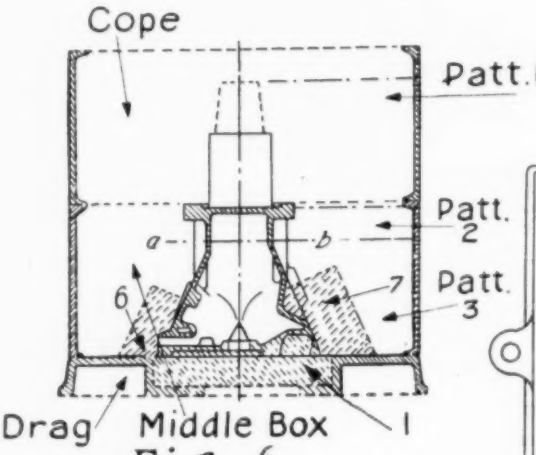


Fig. 6

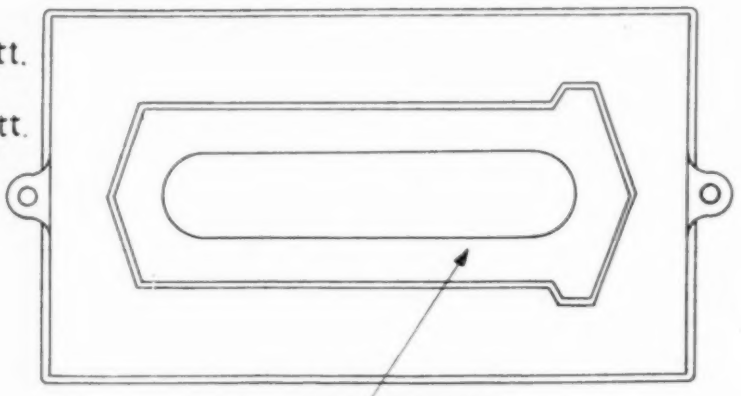


Fig. 7

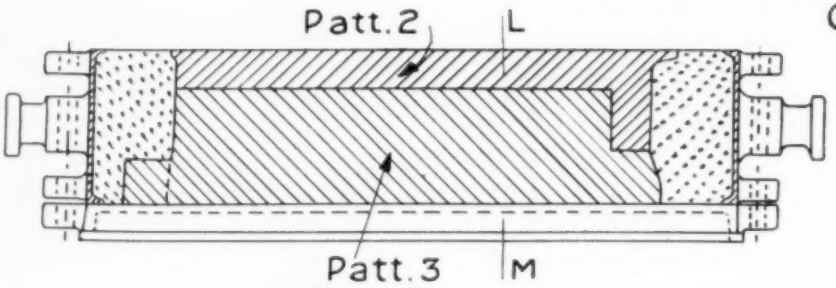


Fig. 8

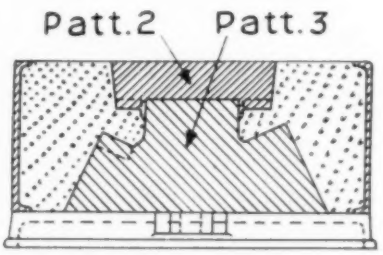


Fig. 9

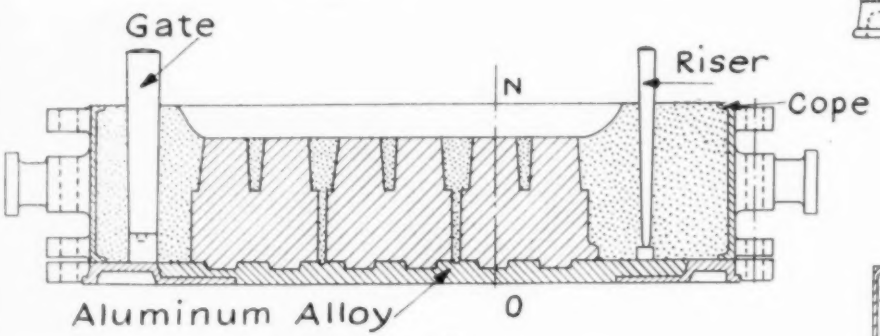


Fig. 10

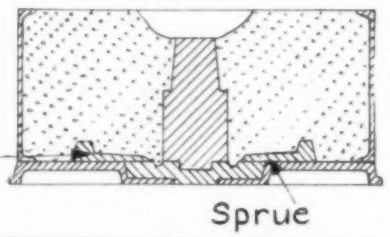


Fig. 11

FIG. 2—A LONGITUDINAL SECTION TAKEN THROUGH THE CENTER OF THE CYLINDER FIGS. 3, 4, AND 5—CROSS SECTIONS TAKEN AT THE POINTS INDICATED FIG. 6—DIVIDING LINES OF THE FLASK DO NOT COINCIDE WITH THE DIVIDING LINES OF THE PATTERN FIG. 7—CAST IRON CORE PRINT FRAME WHICH TAKES THE PLACE OF A DRAG FIGS. 8 AND 9—LONGITUDINAL AND CROSS SECTION OF CHEEK RAMMED WITH PATTERN IN PLACE FIGS. 10 AND 11—LONGITUDINAL AND CROSS SECTION VIEW OF COPE RAMMED UP WITH PATTERN IN PLACE

flasks are of heavy cast iron construction, provided with sand strips top and bottom on the inside and with suitable lugs and trunions on the outside. To insure perfect alignment of the different parts of the flask, holes are drilled right through the trunions in the cheek so that the long guide pins may engage the holes in both the upper and lower guide lugs.

The molds, that is the cheeks and copes, are rammed on shockless jarring machines. As already mentioned the drag simply is an iron frame on which the cores and mold are assembled. After the molds have been rammed and removed from the machines they are blacked with a solution of plumbago and dried in a set of ovens provided for that purpose.

The principal cores entering into the formation of the mold are shown in Figs. 14, 15 and 16. They include the foundation core 1, the water outlet core 3 and its cover core 2, the water jacket core of the cylinder head 4, the under gear casing core 5, the upper gear casing core 14, the right and left lightening cores 6 and 7, an inlet valve core 8, an exhaust valve core 9, the cylinder water jacket core 10 and the barrel cores 16. Some other less important cores will be mentioned later. Each cylinder mold requires 43 cores altogether. The method of assembling the cores in the mold is shown in Fig. 16 and may be described briefly as follows.

The drag is laid upon two rails horizontally adjusted level, then the foundation core 1, the under gear case core 5 and the water jacket core of the cylinder head 4 are put in. The distance between the foundation core 1 and the water jacket core 4 is only 4 millimeters and has to be secured and maintained by double-headed chaplets. Now two stay cores 18 and one stay core 19 are laid in to support the water outlet cores and the small lightening core. Then the water outlet cores 3 are pushed into suitable prints in the foundation core 1 and over each of them a cover core 2 is placed. The proper distance between these cores also is secured by a number of small double headed chaplets.

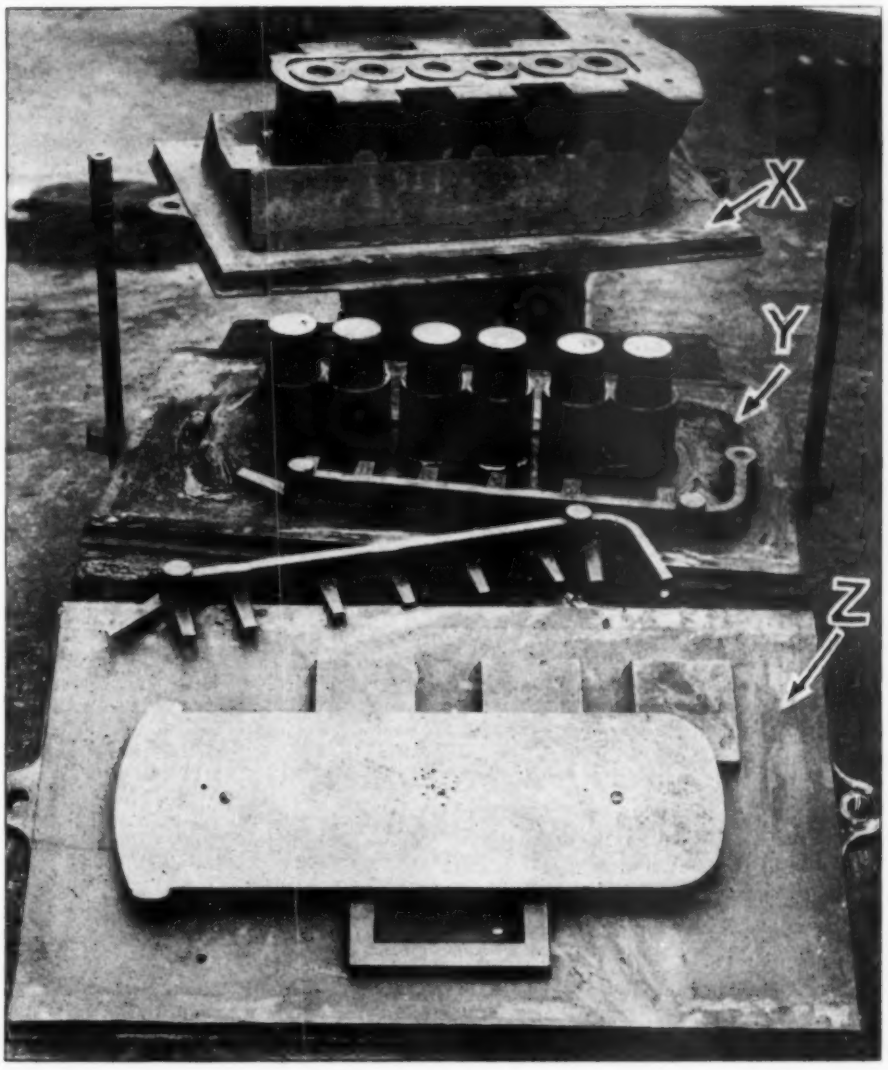


FIG. 13—PATTERN PARTS MOUNTED ON THEIR RESPECTIVE MOLD BOARDS—THE DRAG BOARD IS NO LONGER USED, HAVING BEEN REPLACED BY THE DRAG SHOWN IN FIG. 7

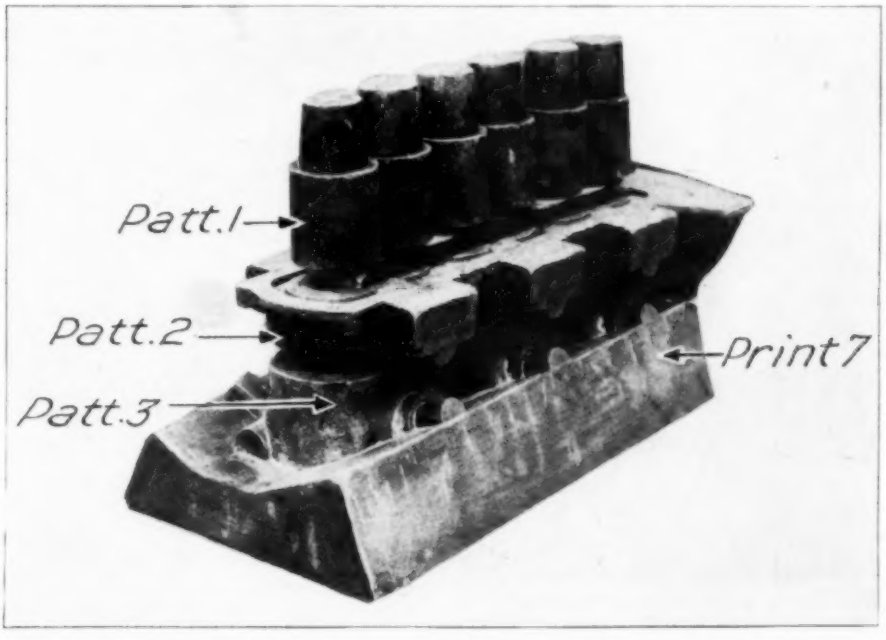


FIG. 12—THE PATTERN IS DIVIDED INTO THREE SEPARATE PARTS

The lateral lightening cores 6 and 7 are laid in defining the outer walls of the casting and at the same time forming the prints for the inlet and exhaust valve cores 8 and 9 which are to be put in later. These different steps are illustrated in several of the sectional views. Figs. 17 and 18 show the foundation core 1, under gear case core 5 and cylinder water jacket core 4 in place and Fig. 19 shows a general view of these united cores. The sections 20 and 21 show the small water inlet cores 3 (Figs. 15 and 16), with their supporting cores 18 and cover cores 2.

The lightening cores 6 and 7 are set into the mold as shown in Figs. 22 and

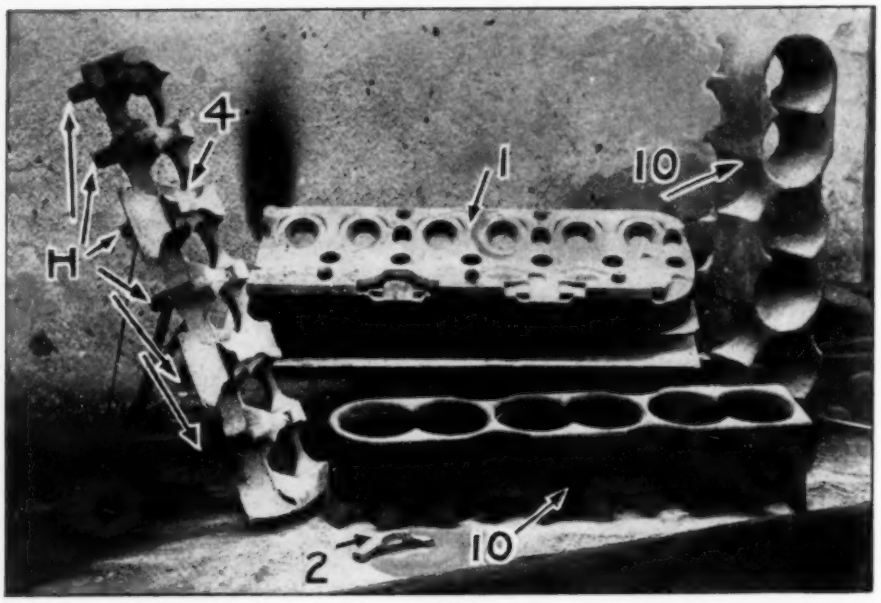


FIG. 14—THE FOUNDATION CORE, 1, THE CYLINDER HEAD WATER JACKET CORE, 4, AND THE CYLINDER WATER JACKET CORE, 10

23. They supply the necessary guide for setting the inlet valve cores and the exhaust valve cores. Fig. 24 distinctly shows the position of the two lightening cores 6 and 7 while Fig. 22 shows a longitudinal section through the drag at this stage and Fig. 24 shows an upper view of the cores put in up to this time. The gas from core 1 escapes freely through the open bottom of the drag, that of the water jacket core of the cylinder head through its prints *H* (Figs. 14 and 22). In the same manner the inlet and exhaust cores 8 and 9 are vented through their bottom prints (Fig. 23). The lightening cores 6 and 7 do not require any vent.

After the cylinder water jacket core 10 (Figs. 22 and 23) has been set the position of all the cores is checked by several gages provided for that purpose and then the cheek part of the mold is lowered into place.

At this point it is necessary to provide a vent for the cylinder head water jacket core 10. Venting through the bottom is nearly impossible for this core rests only on the small ribs *K* Fig. 22. It is vented through holes which are formed by small cylindrical cores 11 (Figs. 26, 27 and 28). The ends of these cores are dipped in flour paste then dropped into core prints in the cheek and squeezed against the water jacket core in which holes have been provided for releasing the air and gas.

Instead of *making up* the core print with green sand, a cover core, 12, is set over each of the little vent cores and the space behind it filled with fine coke. Fig. 27 shows a section through a cylindrical venting core 11 and a cover core

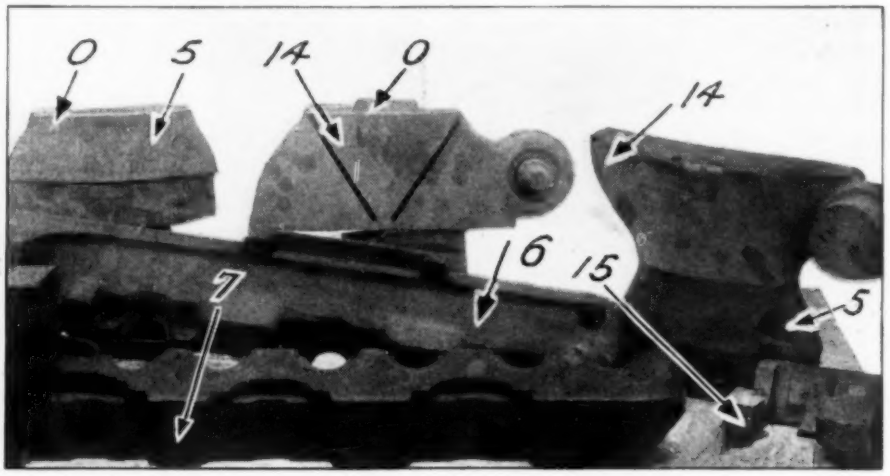


FIG. 15—THE UPPER AND LOWER GEAR CASING CORES, 5 AND 14, AND THE TWO OUTSIDE LIGHTENING CORES, 6 AND 7

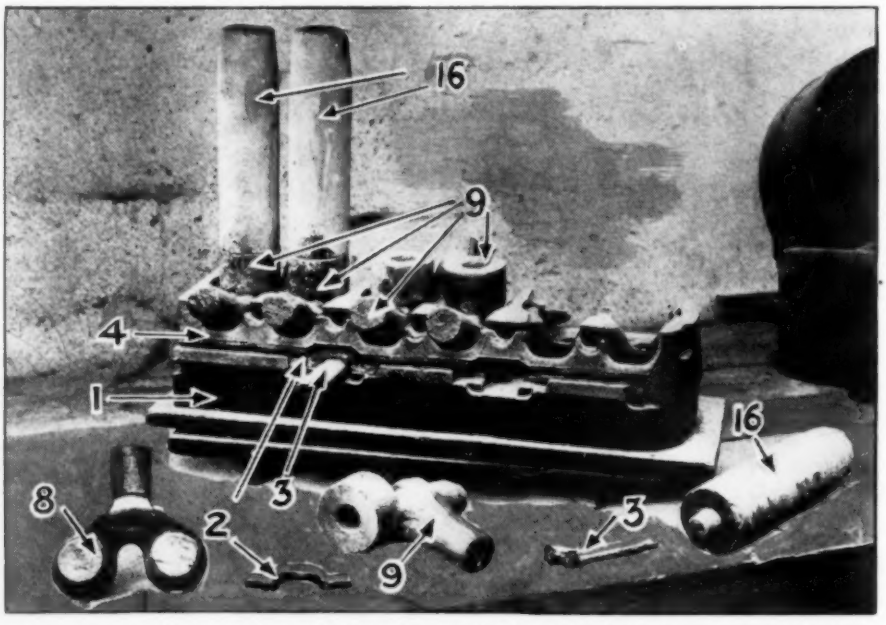


FIG. 16—THE INLET VALVE CORE, 8, THE EXHAUST VALVE CORE, 9, THE FOUNDATION CORE, 1, THE WATER OUTLET CORE, 3, AND ITS COVER CORE, 2, THE CYLINDER HEAD WATER JACKET CORE, 4 AND THE BARREL CORES, 16

12 and Fig. 28 represents a view on the middle or cheek after setting in these cores.

The holes left by these venting cores are a convenience when the time comes to remove the sand forming the water jacket core from the casting. The openings are indicated at *H* Fig. 1. After setting in and securing these cores the molder uses a bent vent wire to form an exit for the gases.

To ascertain whether the cylinder water jacket core has been located accurately, or not, double headed chaplets are set on its top and a small pinch of plaster of paris placed on each one. The cope is then tried on and off again to see whether the double headed chaplets fit exactly in their proper relative position. Having made any necessary adjustment the upper gear casing core 14 which fits with print *O* Figs. 15 and 25 to the under core 5 is put in place.

At this point a few cores which are

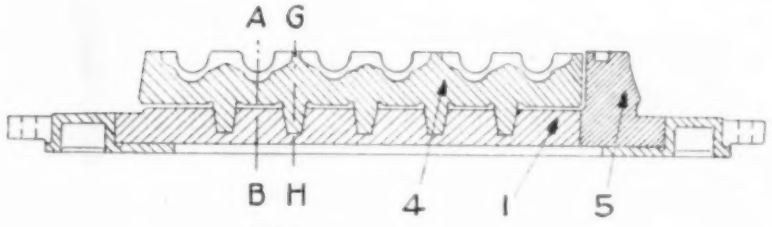


Fig. 17

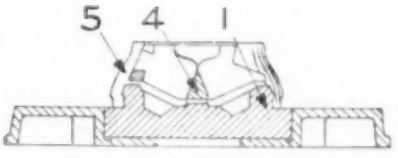


Fig. 18

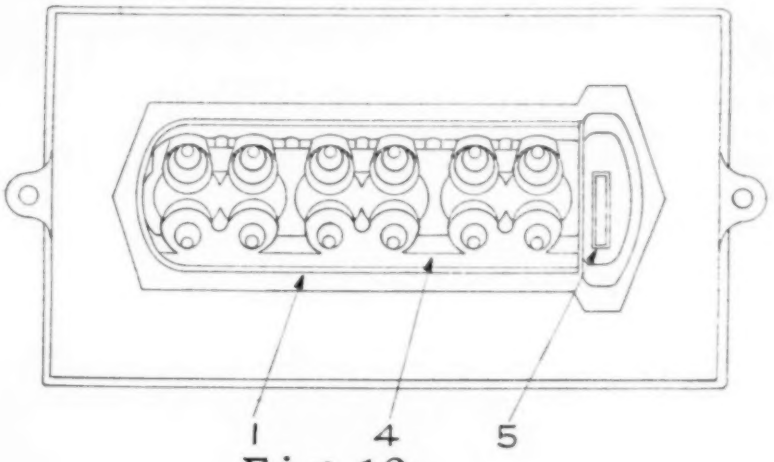


Fig. 19

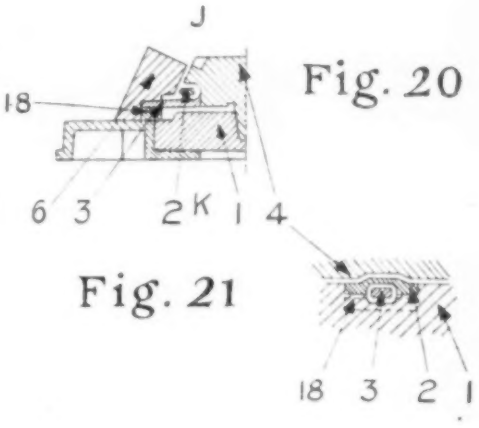


Fig. 20

Fig. 21

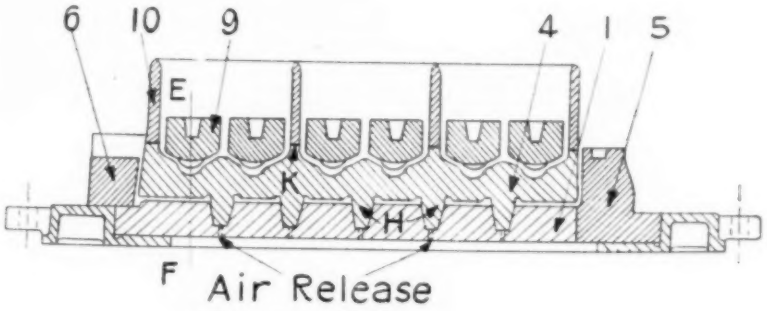


Fig. 22

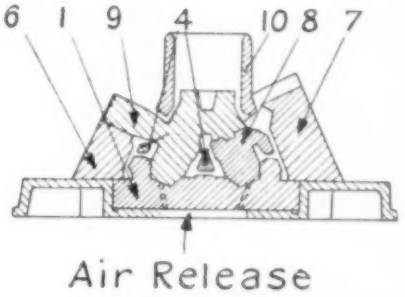


Fig. 23

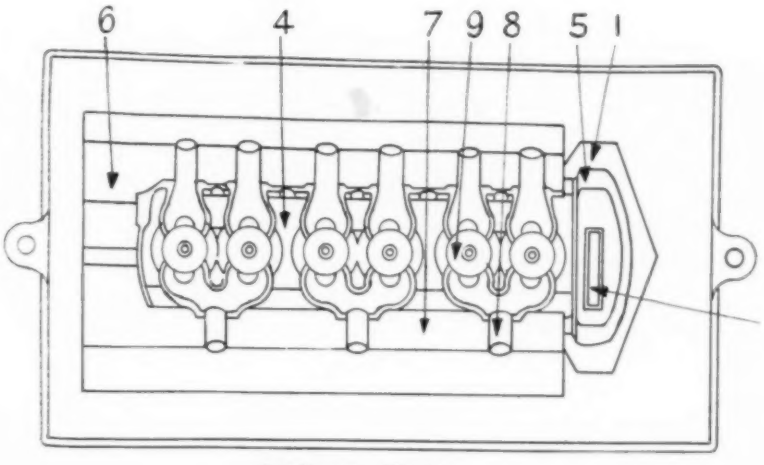


Fig. 24

FIGS. 17 AND 18—LONGITUDINAL AND CROSS SECTION THROUGH THE DRAG AFTER SETTING THE CORES, 1, 4 AND 5 FIG. 19—UPPER VIEW FROM *A* IN FIGS. 17 AND 18 FIG. 20—SECTION G-H, FIG. 17 FIG. 21—SECTION J-K, FIG. 20 THE WATER OUTLET CORE, 3, AND ITS STAYING CORE, 18, AND ITS COVER CORE, 2 (SEE ALSO FIGS. 17 AND 24) FIGS. 22 AND 23—LONGITUDINAL AND CROSS SECTION THROUGH THE DRAG AFTER SETTING IN CORES 6, 9 AND 10 FIG. 24—VIEW FROM *B* IN FIGS. 22 AND 23 BEFORE SETTING THE WATER JACKET CORE, 10, IN PLACE

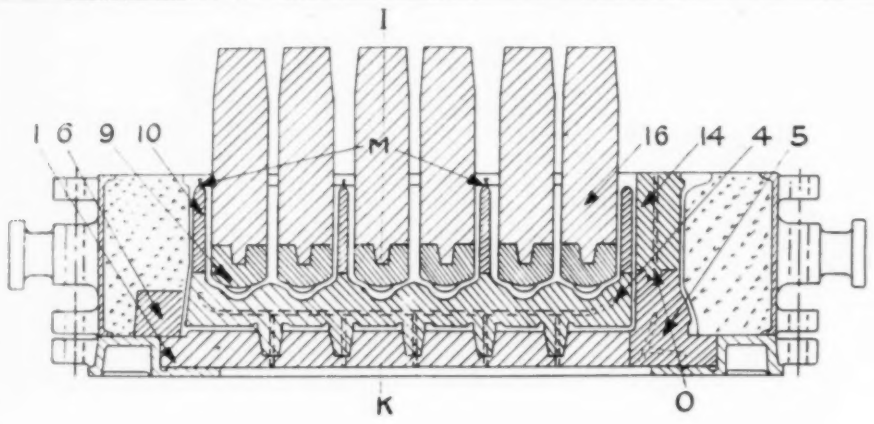
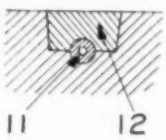


Fig. 25

Fig. 27



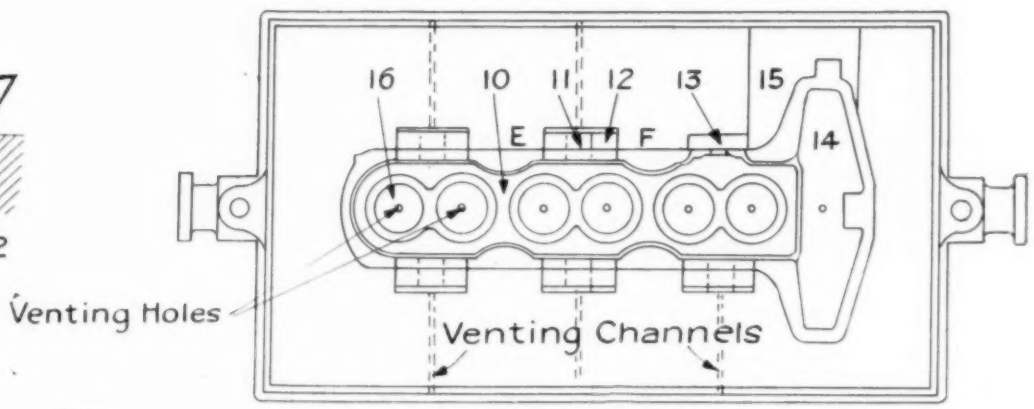


Fig. 28

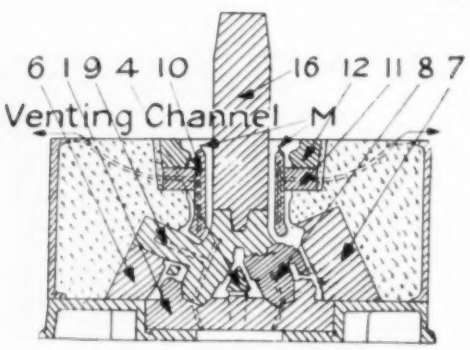


Fig. 26

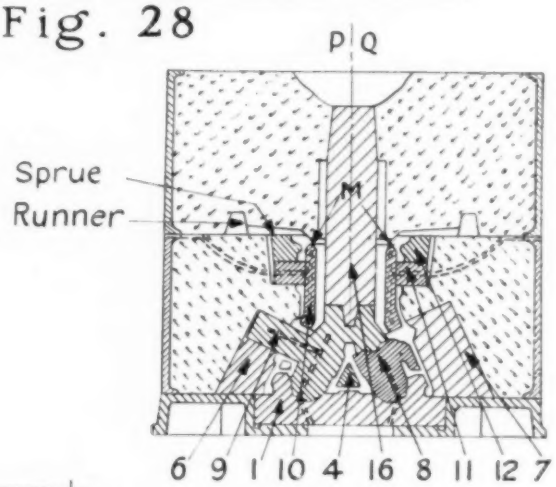


Fig. 30

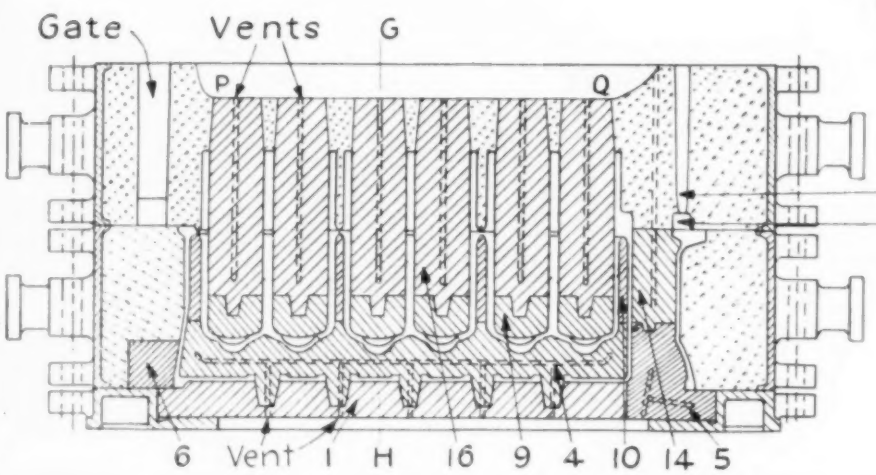


Fig. 29

FIG. 25—LONGITUDINAL SECTION OF THE MOLD JUST PREVIOUS TO SETTING ON THE COPE. FIG. 26—CROSS SECTION AT J-K. FIG. 27—SECTION *E F*. FIG. 28—VENTING CORE 11 AND THE COVER CORE 12. FIG. 28—VIEW FROM JOINT *C* IN FIGS. 25 AND 26. FIG. 29—LONGITUDINAL SECTION THROUGH THE COMPLETE MOLD. FIG. 30—CROSS SECTION TAKEN AT G-H, FIG. 29

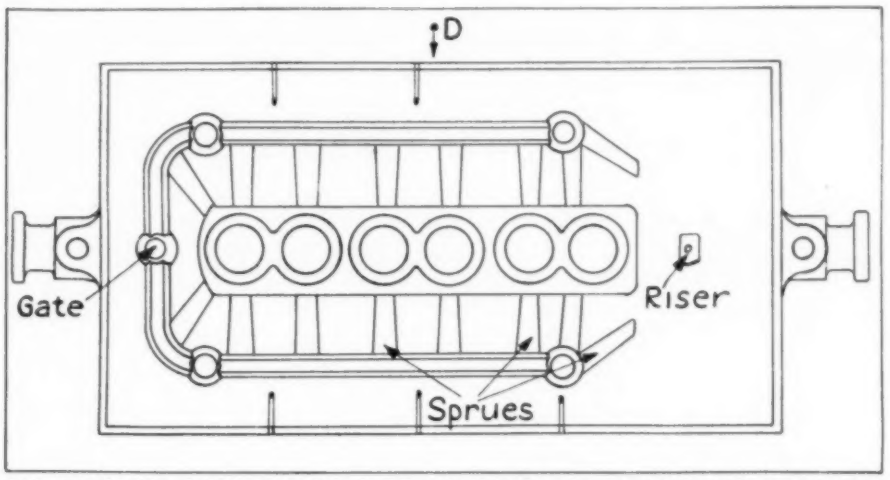


FIG. 31—JOINT SIDE OF THE COPE SHOWING THE ARRANGEMENT OF THE GATES RUNNER, SPRUE AND RISER

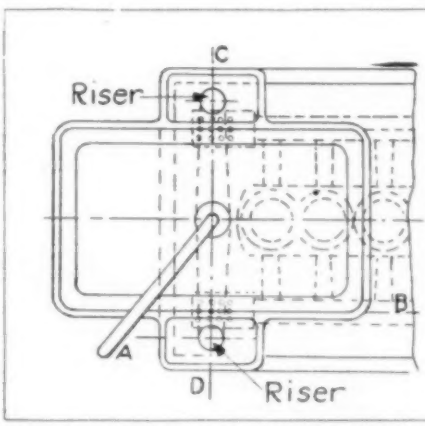
not shown in the illustrations are set into the mold and the six large barrel cores, 16, Fig. 17 are set into prints provided in the upper side of the exhaust valve cores, 9. The position of these cores is tested by a gage after which the cope is set on. This state of the mold is shown in Figs. 29 and 30 both in longitudinal and cross section.

The barrel core prints are cut right through the cope so that it is possible to watch the barrel cores while lowering the cope into place. As soon as the cope rests definitely on the middle part of the flask a venting rod is stuck in the top of each barrel core and the opening around the print packed full of green sand, after which the rods are pulled out leaving a vent passage for the gas escaping from the barrel cores.

Fig. 31 shows the general arrangement of the gate, runners, inlets, sprues and risers. All the parts are located in the cope. Originally a pouring basin with head sunk in the cope was built up and the metal cast into the mold through it without making any provision to clean the iron. A riser was set on the boss *R*, Figs. 31 and 29, by means of which some iron was made to flow through. Later is was decided to take precautions to clean the iron from slag and dross. For this purpose a grate core Figs. 32 and 33 was inserted between the gate and runner so that all the iron has to flow through it before reaching the runner and mold.

A cast-iron feed runner box Figs. 32, 33 and 34 has been adopted for pouring these castings. It is large enough to hold enough liquid iron to pour one cylinder casting. The bottom hole is closed with a cast iron ball or plug provided with a suitable handle for lifting it out after the basin is filled with iron. Two small boxes for the scum risers are provided on the right and left of the main runner box.

Before starting to pour, the plug ball is set on the upper opening of the gate and after the box has been filled with liquid iron the ball is lifted allowing the iron to rush into the gate. It flows to the right and left in the side channels



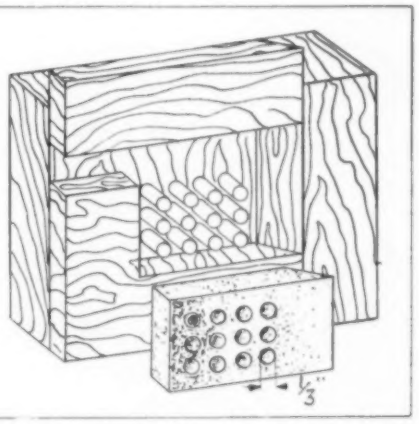


FIG. 34—UPPER VIEW OF RUNNER BOX FIG. 35—STRAINER CORE AND CORE-BOX IN WHICH IT IS MADE

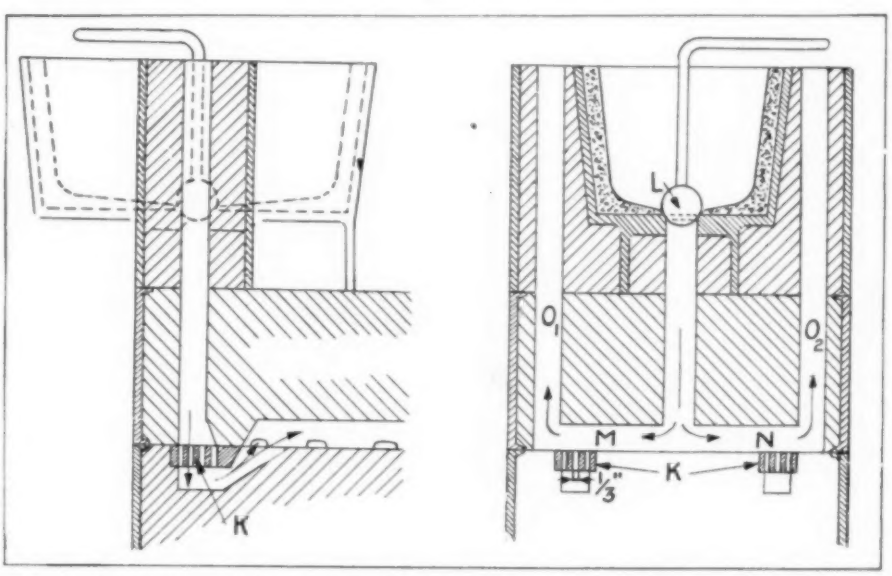


FIG. 32—SECTION *A-B* (FIG. 36) THROUGH THE RUNNER BOX AND GRATE CORE *K*
FIG. 33—CROSS SECTION *C-D* (FIG. 34) THROUGH THE RUNNER BOX AND THE COPE

M and *N* and mounts up into the scum risers 01 and 02, Fig. 33, driving the scum and dross to the top of the risers. The clean iron flows down through the grate cores *K* and after having passed them rises again high up into the distribution runners spaced along the cope joint as shown in Figs. 13 and 31.

This method of pouring has proved most satisfactory, especially as it dispenses with all risers with the exception of the two scum risers attached to the runner box. The cast iron basins are daubed with loam and thoroughly dried so that they may be used repeatedly with the same loam layer. The amount of iron the basin will hold corresponds to the amount of iron required to pour the casting. Therefore, when the mold is full the basin is empty and can be lifted off and used on another flask. The flasks are not weighted before pouring; the parts are held together by a number of iron clamps similar to those shown in Fig. 36. Instead of clamps extending from the bottom plate to the top of the cope,

clamps of a truncated triangular shape are employed. It is obvious that with this type of clamp no wedges are required. The clamp is set on embracing the two lugs and a slight tap of a hammer is sufficient to tighten it. For the same reason, it is just as easy to knock them off after the mold has been poured.

As already stated, the work of preparing the cylinder molds has been extensively sub-divided among many groups of workmen. One gang prepares the oil mixtures for the cores, a second gang makes the cores and a third gang blacks them and carries them to and from the drying ovens. The cores are dried in automatically controlled core ovens which can be held to a limit of 5 degrees anywhere between 50 and 300 degrees Cent. A fourth gang examines the dried cores, attends to any necessary repairs and partly assembles them.

The foundation core, 1, the cylinder head water jacket core, 4, and the water inlet cores, 2, and 3, always are delivered as a unit to the molders. Another group of workmen sets in the cores, checking and adjusting each layer of cores carefully with the necessary jigs and gages.

Analysis of Cylinder Iron

The molds are poured from a crane ladle. The runner boxes are lifted off immediately after the mold has been poured but the castings are not shaken out until two hours later. A special group of workmen shakes out the castings at night and also cuts over the sand so that everything is in readiness for the molders on the following morning.

The iron for these automobile engine cylinders conforms to the following average analysis: combined carbon 0.59 per cent; graphitic carbon 2.72 per cent; silicon 2.30 per cent; manganese 0.66 per cent; phosphorus 0.36 per cent and sulphur 0.10 per cent.

The iron is melted in a 25-inch cupola with an air pressure of 8 to 9 ounces and with 900 pounds of iron to 100 pounds of coke and 20 pounds of limestone. The iron leaves the cupola so superheated that it smokes. It is taken to the casting floors in buggy ladles running on a narrow gage track. The finished castings are subjected to a water pressure of 145 pounds per square inch. Nevertheless the percentage of rejected castings is low.

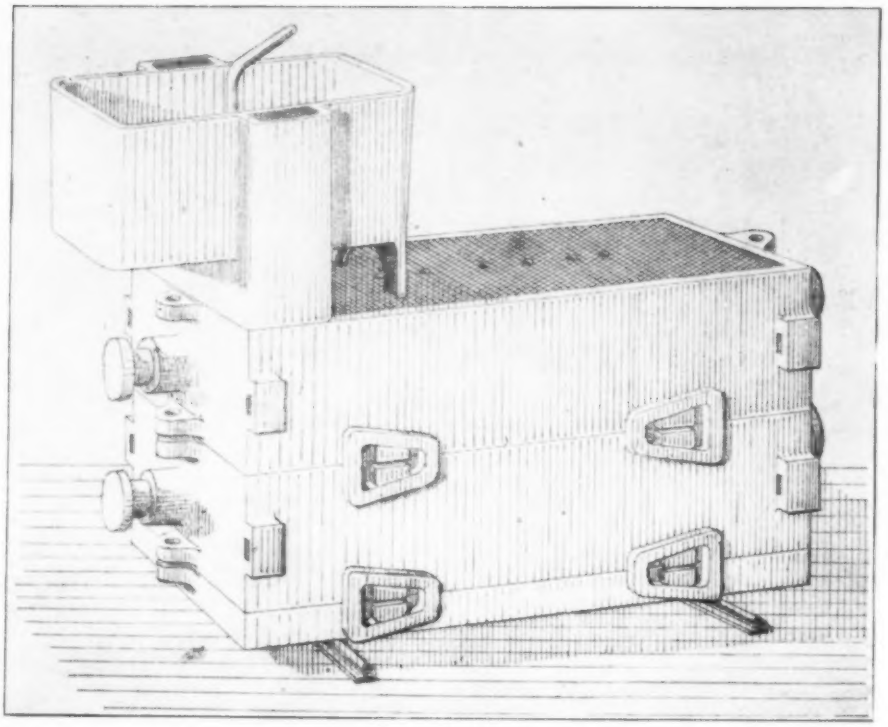


FIG. 38—COMPLETED CYLINDER MOLD WITH RUNNER BOX AND CLAMPS IN PLACE

Sulphur Reduced in Acid Lined Furnace

So many statements have been made similar to the one by Dr. Richard Moldenke, published in THE FOUNDRY of March 15, to the effect that sulphur cannot be removed from cast iron when using an acid-lined furnace, that the writer thinks this impression should be corrected. The conclusions may be deduced from electric furnace steel practice but it is not true when melting gray iron on an acid bottom. Several acid-lined furnaces on the Pacific coast are producing gray iron with less than 0.05, and sometimes as low as 0.02 per cent sulphur, using scrap with as high as 0.20 per cent sulphur.

From 10 to 25 pounds of a mixture of burned lime and coke dust is used per ton of iron melted. Fluor spar is not added unless the lime begins to form crusts on the side walls of the furnace as sometimes happens. The cutting action of the lime on the side walls is extremely slight for the metal does not boil during melting as is the case with steel. Again the coke in the mixture assists in preventing the lime from reacing the side walls in sufficient quantity to do any serious damage.

The acid-lined furnace increases the silicon content of the molten metal only slightly, unless the metal is heated so hot as to cause dripping from the side walls and arch, or when a poor bottom comes up in contact with the white hot coke on top of the bath. To absorb an appreciable amount of silicon from the lining, the metal must be white hot and held in the furnace for an excessive length of time, which is poor melting practice.

Experience over a period of three years has shown that the acid lining in the electric furnace can be used to produce high grade gray iron, low in sulphur from a charge containing high sulphur scrap. The writer believes those operating electric furnaces would find it more economical to operate with an acid lining, and would obtain good results by using fine burned lime and coke dust to remove sulphur and adding fluor spar sparingly.

Again Heads American Gear Manufacturers

The American Gear Manufacturers' association re-elected F. W. Sinram, Van Dorn & Dutton Co., Cleveland, president, at the closing session of the annual convention at the Sinton hotel, Cincinnati, April 30. R. P. Johnson, Warner Gear Co., Muncie, Ind. and B. Y. Waterman, Brown & Sharpe Mfg. Co., Providence, R. I., were elected vice presidents and Frank D. Hamlin, Earlo Gear & Machine Co., Philadelphia, was recommissioned secretary-treasurer.

The association went on record as favoring and promising its co-operation in, bringing about standardization of gear wheels and equipment.

At the annual banquet, Edward S. Jordan, president of the Jordan Motor Car Co., Cleveland, delivered an address on "Looking Ahead", and Charles Woodward, vice president of the Hydraulic Pressed Steel Co., Cleveland, spoke on "The Personal Element in Business."

Propellers Cast in British Shop-II

Method of Making the Cope and Striking Up the Boss or Hub—Melting Methods Including the Character of the Charge and Pyrometric Control Are Clearly Outlined

BY WESLEY J. LAMBERT

THE cope for a propeller mold consists usually of an iron grid or wicker-work, filled with loam, and suitably strengthened with wire. It is finally bricked to meet a top plate—one for each blade—which is horizontal and so is parallel to the bottom casting plate. It is bolted and clamped to ensure its unbroken removal. With small propellers the top plates often are not used, the brickwork walls, strengthened by strong iron wire, being considered sufficiently rigid. Grids, however, are not universally used, and the cope is often reinforced with iron rods only. The grid has, none the less, definite advantages;—it is stronger, it is easily adjusted, and it requires much less thickness of loam, usually about 2 inches only, which facilitates the subsequent drying to a very appreciable extent.

The grid, Fig. 12, consists of a cast-iron binder which fits on a seating on the top surface of the bottom portion of the mold, and is provided with two rings for lifting, and two large lugs on which the cope stands when removed for finishing. Cast into the form or binder are a large number of iron rods, fixed in line along its inner edge at intervals of about 2 inches. These can be bent to fit the back of the blade pattern. They are crossed, approximately at right angles, by other rods, and the whole is securely wired, so that the grid is rigid and strong. The cross-irons towards the root of the blade are bent to form a reinforcement for the wall of loam around the boss.

To adjust the grid in position, wooden blocks between ½ and ¾ inch in thickness are placed upon the seating and upper edge of the mold. The grid is fitted on these blocks, its irons bent to the required shape, the crossirons securely wired, and a third ring for lifting fixed to its upper part. The grid, together with the blocks, is then removed, a layer of loam is placed over the whole mold area, and the grid replaced in position and firmly bedded on the loam. It is then covered with a layer of loam, which is smoothed off after the walls supporting the top plate have been built.

The striking board for the boss shown in Fig. 8 of the preceding installment is fitted on the spindle as the building of the cope proceeds. The clamping

FIG. 10—GENERAL VIEW OF CASTING DEPARTMENT SHOWING A PROPELLER BEING TAKEN FROM THE MOLDING PIT

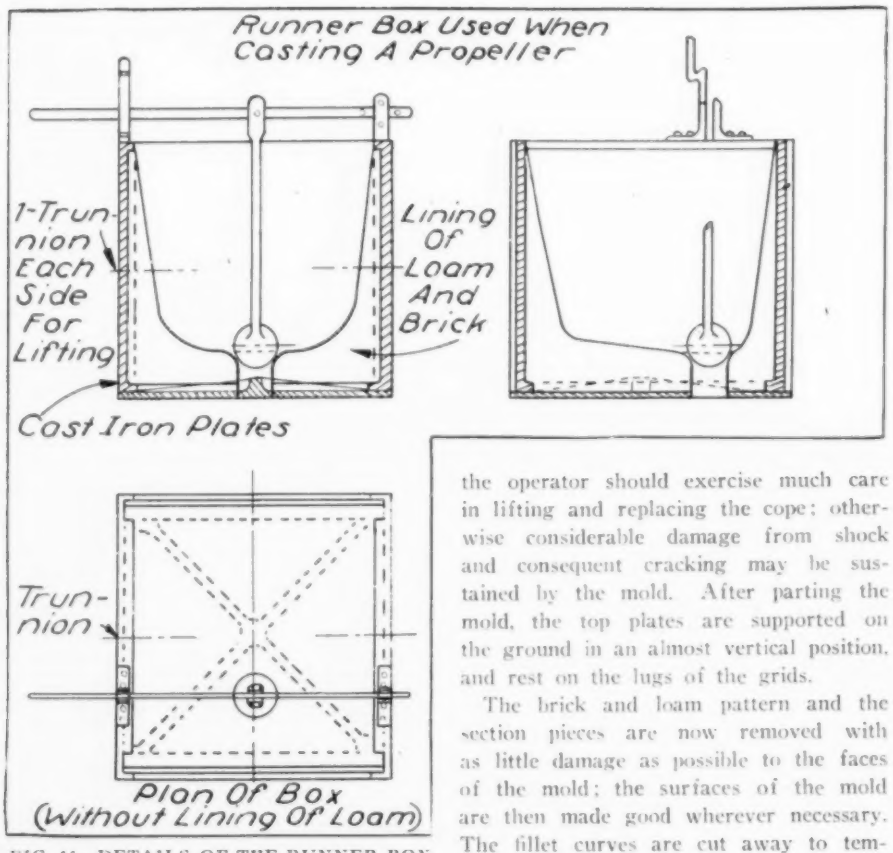

Runner Box Used When Casting A Propeller
1-Trunnion Each Side For Lifting
Lining Of Loam And Brick
Cast Iron Plates
Trunnion
Plan Of Box (Without Lining Of Loam)

FIG. 11—DETAILS OF THE RUNNER BOX

collar is so adjusted that the tooth on the boss board meets the center lines of the blade faces, and the whole of the boss is struck up. After the top plates have been adjusted, if such be used, and the necessary bolting has taken place, the boss board and spindle are removed. The mold should now be dried for, roughly, 36 hours, covering two nights.

After the mold is withdrawn from the oven, the interior of the boss is chipped out along the lines where parting will take place. This facilitates the clean removal of the cope. It is of great importance that the crane should be capable of delicate handling, and that the operator should exercise much care in lifting and replacing the cope; otherwise considerable damage from shock and consequent cracking may be sustained by the mold. After parting the mold, the top plates are supported on the ground in an almost vertical position, and rest on the lugs of the grids.

The brick and loam pattern and the section pieces are now removed with as little damage as possible to the faces of the mold; the surfaces of the mold are then made good wherever necessary. The fillet curves are cut away to template and the curved surface rubbed smooth. The faces of the mold are likewise smoothed, the blade edges are trimmed and finished, and all unevenness of surface is removed. The openings of the test bar recesses are similarly trimmed. The boss is also rubbed down and finished. All the interior surfaces of the mold are now blackened and finally dressed.

The tops are replaced upon the mold, but are kept from contact by bricks placed on the seating and edges. Thus during drying, the hot air of the stove will be able to gain easy access to all parts of the mold. Care should be taken when moving finished molds in and out of the ovens to avoid shocks, such as might occur through uneven floors or rough handling, as any carelessness may result in serious cracking of the mold. The mold is withdrawn after one night in the oven. The cope is lifted off and the mold thoroughly brushed to remove any dirt. Any remaining dust is removed by compressed air. The tops are now replaced with great care, their edges being adjusted by means of marks previously made. The joints to the bed should be made up with loam.

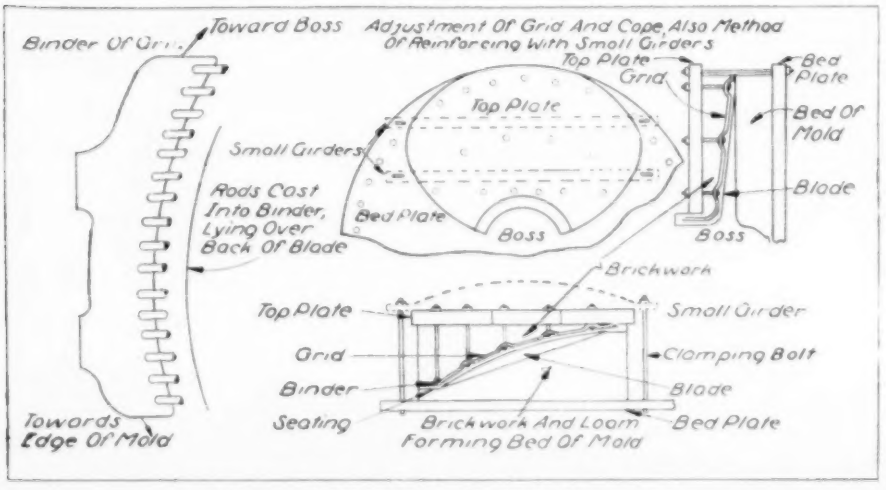


FIG. 12—ADJUSTMENT OF GRID AND COPE

The assembled mold must be firmly clamped to preclude any possibility of bursting or slipping. If top plates are used, these are secured to the bottom plate by long bolts. Suitable girders also are placed across each blade and bolted to the bed plate. If, as in the case of smaller propellers, no top plates are used, the girders alone are considered to give ample resistance to the bursting force exerted by the molten metal. The mold must be secured against collapsing and slipping, that is, against the tendency of the cope to move down the bed. This is obviated by fixing metal bars vertically between the plates, wedged to the required distance and wired to the clamping bolts. When the mold is placed in the casting pit the vertical portion of the runner should be built up securely, and the whole mold surrounded by rammed sand and interlocking plates, if available. The sand should be tightly rammed at all joints where the tops meet the bed. This prevents escape of metal. Around the boss all joints are carefully filled with loam and dressed. The head mold is now placed in position. It consists of a wide collar of brickwork held between two rim-plates, from 10 to 30 inches in depth, according to the size of the propeller. It should be the same diameter as the top of the boss, and be placed concentrically. The joint of the boss and head must be finished with loam and carefully dressed.

To ensure complete dryness of the mold particularly where the loam has been recently added, local drying must be resorted to. Red-hot weights of cast iron are suspended from a bar placed across the mouth of the head. The mouth is then covered with a piece of sacking to enclose the hot air. Fresh weights should be added as necessary, so that the mold shall be as warm as possible at the time of casting.

After the final drying of the mold for a propeller of large size, a core is fixed into position. The core consists usually of a long perforated iron tube surrounded by a spirally wound straw rope, which itself in turn is entirely enclosed in specially prepared

loam. The core tapers from bottom to top, and it may carry any specified modifications such as the cores for lightening chambers. The core thus struck up is blackened and dressed in all respects similar to the mold itself. It must be fixed absolutely concentric with the boss form.

The vertical portion of the runner is now completed with specially prepared hollow cylinders of loam. This is built up securely to a height just above the overflow level of the head. The runner box, which is described later, is fitted and secured. It is of special importance that the runner be thoroughly dry throughout its whole length. Care must be taken to guard against any escape of metal at the joints in the runner, and between the runner box and the runner.

Provision must be made for a flow-off from the head. A channel should be constructed leading into a pig bed of suitable size, in order that the surplus metal may be recovered in a form convenient for recharging into the furnace.

The procedure followed in making up a mold for a loose blade follows closely on the lines adopted for that of a solid propeller. In the case of a blade, however, a rectangular iron plate is substituted for the circular casting plate upon which the mold is constructed, and in lieu of a spindle mounted in the center of the plate, a permanent spindle supported by brackets is let into the foundry floor. This spindle is furnished in the same manner as that previously described for use in molding a solid propeller, and carries the striking board etc.

The bottom plate is usually supported at an inclination corresponding to that of the pitch, laterally, and contrary to the drop longitudinally, in order to reduce the brickwork to a minimum. A pattern is used in forming the flange, and with this exception the notes already given respecting the preparation of a mold for a solid propeller, refer also, in general, to the whole of the operations required to prepare a mold for a loose blade.

In common with all high class castings made in manganese bronze, the metal used for casting solid propellers and blades is remelted metal, which has been previously made and cast into ingots of 28 pounds weight, or into billets of about 1000 pounds each.

For small casts, the metal is remelted in graphite crucibles or pots, but for heavy castings the metal is remelted in large open-hearth reverberatory furnaces. The latter are specially constructed of superior refractory brickwork with a sloping hearth or *apron* and a *well* to contain the molten metal. A tapping hole is provided which is temporarily closed during the melting operations. A series of doors permits easy access to all parts of the furnace hearth for charging, stirring, and inspection of the metal during the various stages of the melting operation. Fig. 13 shows a battery of three of these large reverberatory furnaces.

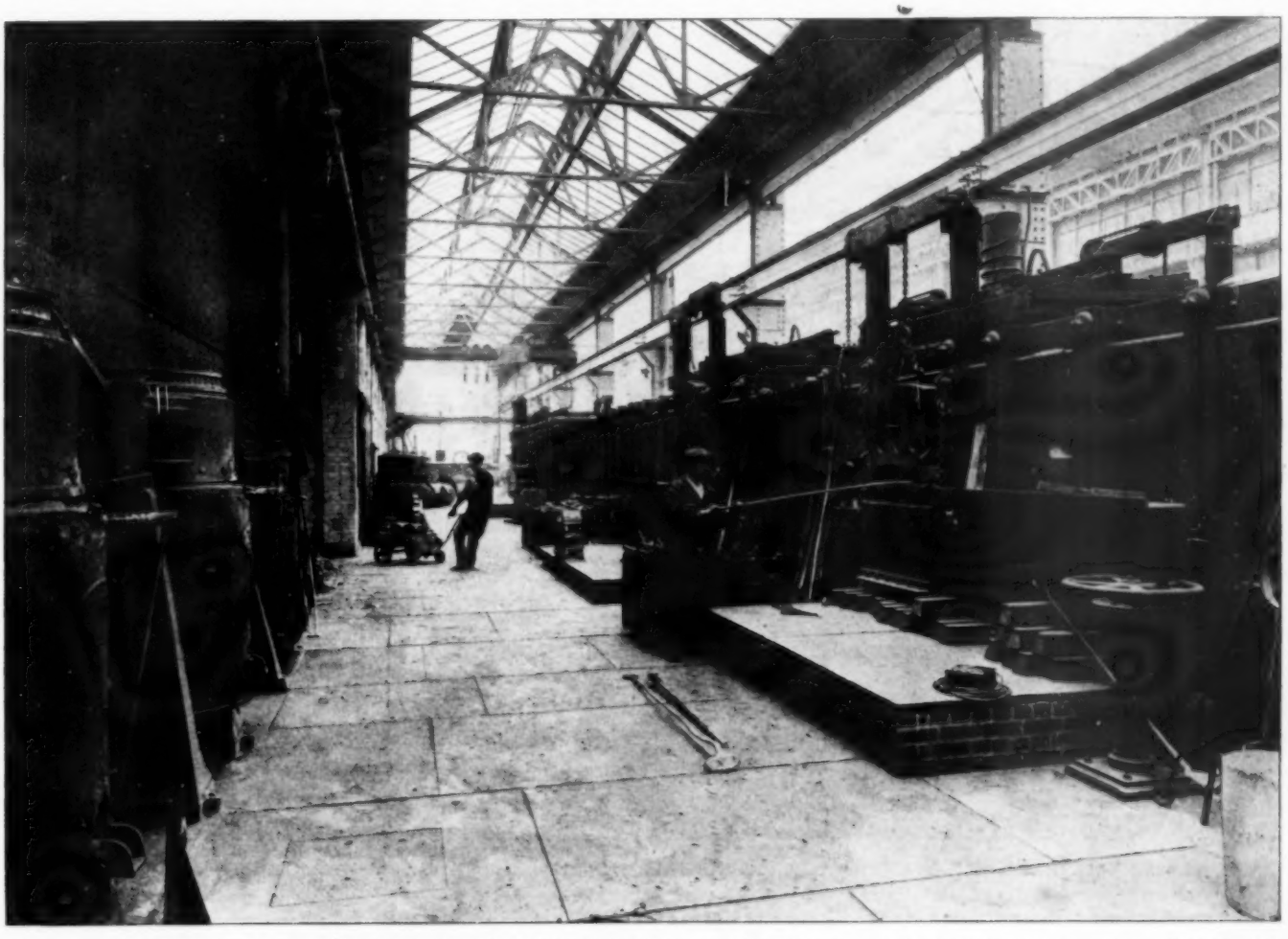


FIG. 13—A BATTERY OF THREE REVERBERATORY MELTING FURNACES IS EMPLOYED—NOTE THE INDICATING PYROMETER INSTRUMENT IN THE FOREGROUND ON THE PLATFORM OF THE FIRST FURNACE

For castings required to give high tests, all new metal, or a mixture of two-thirds new metal with one-third of approved scrap such as heads, runners, overflows, turnings and borings and ingot of propeller bronze may be used. No scrap other than bronze of the same brand as the propeller metal should be used in the mixture with the new metal. In the case of the highest class propeller work, the total weight of metal

to be charged as compared with the finished weight of the propeller should be approximately as 2 to 1. The weight of metal primarily charged into the furnace is dependent upon the capacity of the sloping hearth and the nature of the charge, whether ingot or billet metal. It is always preferable, where possible, to charge the furnace with large scrap billets, heads, overflows, etc., because a charge composed entirely of ingots cannot be introduced except by instalments, and more time is required to melt the metal. This is due to the fact that ingots, when beginning to melt on the hearth, coalesce into a solid mass and require considerable effort to effect their dislodgment into the well. A certain amount of any casting charge is sure to be of ingots, some of which may be placed in the well, but it is always advisable to retain a certain number of ingots as coolers in case the furnace temperature is inclined to run hot.

When a cold furnace is to be charged entirely with ingot metal, only about fifty per cent of the total weight should be placed upon the apron, then the charging door should be closed and the furnace lighted. The metal will gradually melt and run down into the well of the furnace. On account of the difficulty mentioned, the ingots may require to be forced into the well by means of a crowbar, thus leaving the apron free to receive the remaining portions of the charge which should be introduced upon the apron in small lots through the smaller doors. When all the metal is melted the bath is ready for any final additions which may be necessary.

The temperature of the furnace must be carefully regulated to avoid excessive heating with attendant gassing of the metal, and also oxidation of zinc. The temperature of the bath of molten metal should be maintained throughout the melting operations only sufficiently above the freezing point of the particular alloy in use to ensure a margin of temperature for successfully carrying out the casting operation. The temperature of the bath is ascertained from time to time by the insertion of a pyrometer, after a careful rabbling of the metal.

The liquid metal, collected in the well of the furnace during the operation of melting, should not be violently or too frequently rabbled. Inattention to this point results, by exposure of the uncovered metal, in a liability to the production and inclusion of oxides, and consequent alteration of the composition of the original metal. Judicious rabbling, however, is essential to ensure homogeneity in the bath of liquid metal.

The total time from charging a cold furnace to the completion of melting will be from 5 to 8 hours, according to the weight and form of the charge, and the working of the furnace.

The operations immediately concerned with the actual casting of a solid propeller or blade may be summarized in sequence as follows:

Pyrometric control of the metal in the furnace.
Control of the zinc-equivalent.
Tapping-out and skimming.
Pouring the metal.
Skimming the metal in the mold.
Feeding.

The pyrometric control of the temperature of the metal in the furnace, more particularly when the major portion of the metal is melted, is of paramount importance if high-grade castings are required The thermocouple immersion-type pyrometer is frequently used. It consists of an indicator with flexible leads and connector and the thermocouple. The indicator employed must be sensitive. A number of these instruments are of robust construction, and well suited for foundry use.

The thermocouple is composed of two heavy metal wires of dissimilar composition, which are insulated throughout their lengths, except at the fire-end, where they are twisted and fused together to form a junction or couple. The whole is then enclosed in a steel protection tube, from which it must be insulated.

In order to determine the temperature of a bath of molten metal the fire-end

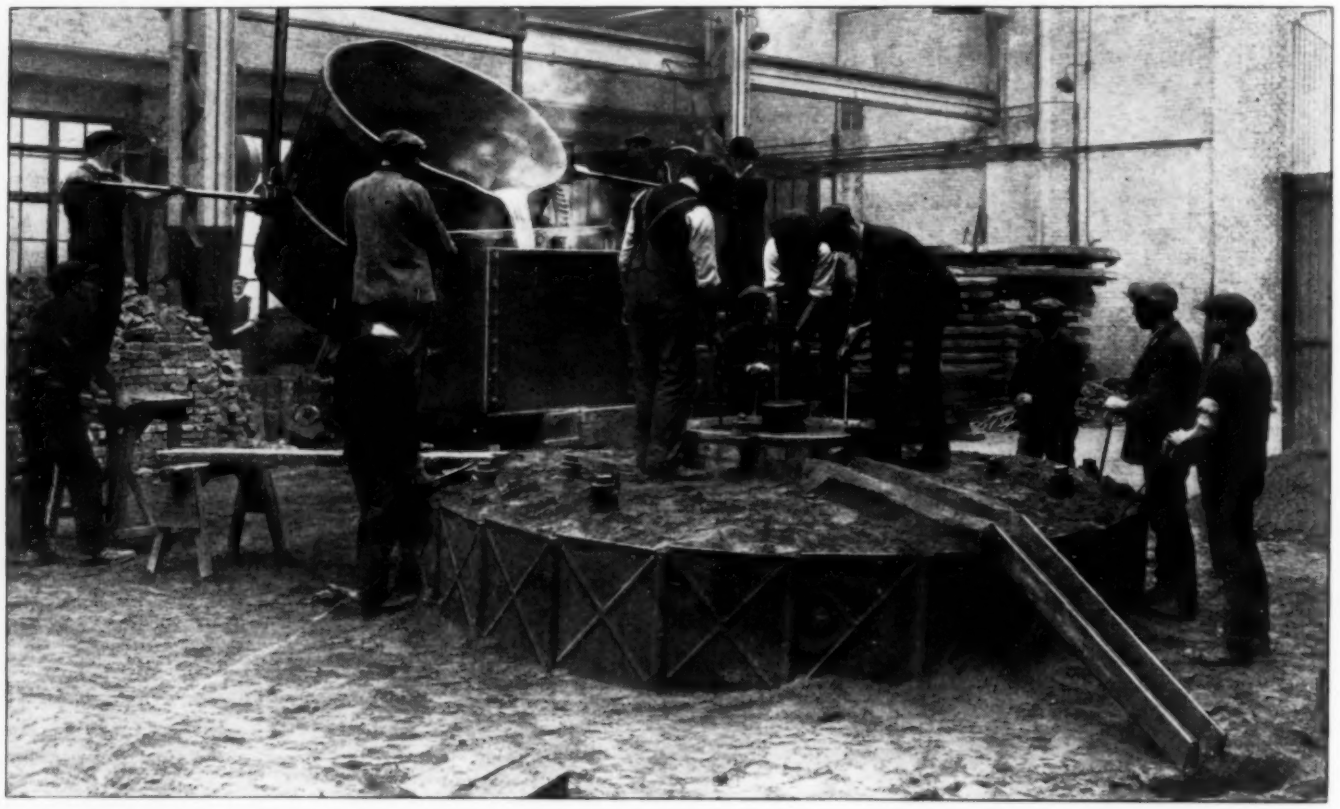


FIG. 14—METAL IS POURED INTO A LARGE RUNNER BOX DETAILS OF WHICH ARE SHOWN IN FIG. 11

of the thermocouple is inserted into the metal to a depth sufficient to ensure that the junction is heated to the same temperature as the metal. About six inches will be found sufficient, care being taken that enough time is allowed for the junction to attain the maximum temperature of the bath of metal before the reading is taken. The wires at the free end of the couple are connected to the indicator by means of the flexible leads. The maximum temperture of the metal is indicated by the needle or pointer traversing the scale. It is obvious that the operator must exercise the necessary precautions against the registration of the flame heat of the furnace gases instead of the temperature of the molten metal.

A temperature of 880 to 980 degrees Cent. may be regarded as the limits covering the range of temperature during any time the metal is in the molten condition. The temperature figure to be aimed at immediately before tapping the metal is naturally higher than the actual casting temperature and depends upon variable factors, namely, the freezing point of the metal, the bulk and cooling rate of the metal, and the interval between tapping the furnace and pouring the metal into the the mold. The freezing point of manganese bronze necessarily depends upon the actual composition of the alloy, but for all practical purposes one may assume that freezing commences at about 880 degrees Cent. A small charge should be tapped at a higher temperature than a large charge.

This control of the zinc equivalent is highly important because of the readiness with which zinc oxidises. Any excessive furnace temperature may cause a serious diminution of the amount of this metal in the alloy. The control is carried out in two ways, according to the type of metal in the furnace. The one way is by observation of the *sparkle* to be seen upon the freshly broken surface of a fractured bar; the other is by micrographic computation of the alpha and beta percentages in such alloys as show no sparkle.

Before the metal is tapped from the furnace small ingots are cast in open-topped horizontal molds of cast iron. Such ingots furnish the necessary bars upon which control-determinations are made, either by visual comparison with standard fractures, or by microscopic analysis, as may be necessitated by the nature of the particular alloy.

This adjustment of the zinc content immediately before tapping the furnace is rendered imperative, as it is obviously impossible to accurately calculate the loss of zinc which will be occasioned on remelting the bronze in an open furnace. Such loss is dependent on the period during which the metal is molten; the temperature of the metal; the nature of the atmosphere maintained through the melting operation, and the exposure of the metal due to rabbling or stirring. The loss of zinc is corrected by the addition of pure spelter to the molten metal, the amount to be added being determined by an experienced metallurgist in the manner indicated.

The metal having been brought to the correct composition and temperature, is then tapped from the furnace into a ladle of sufficient size to take the whole quantity, and with ample margin to permit of its being safely lifted and carried by a crane to the mold. Tapping should never take place until it has been ascertained that everything is in readiness for the metal to be transferred from the ladle to the mold.

A runner box Fig. 11, of such dimensions as to hold about one-third of the gross weight of the casting should be in position immediately over the down gate mold, a ball plug sufficing to temporarily seal the opening in the bottom of the box. Both the ladle and the runner box are lined with refractory material of low thermal conductivity, and are also preheated before introducing the metal in order to guard against prematurely chilling it.

The metal in the container is carefully skimmed free from dross by an experienced man using a heated skimming iron. It is then carried to the runner box and poured metal is introduced into the mold by raising the ball plug, the level of the metal in the runner box being maintained by the addition of further metal from the ladle, Fig. 14.

The runner box serves a dual purpose, in that being constructed to effect

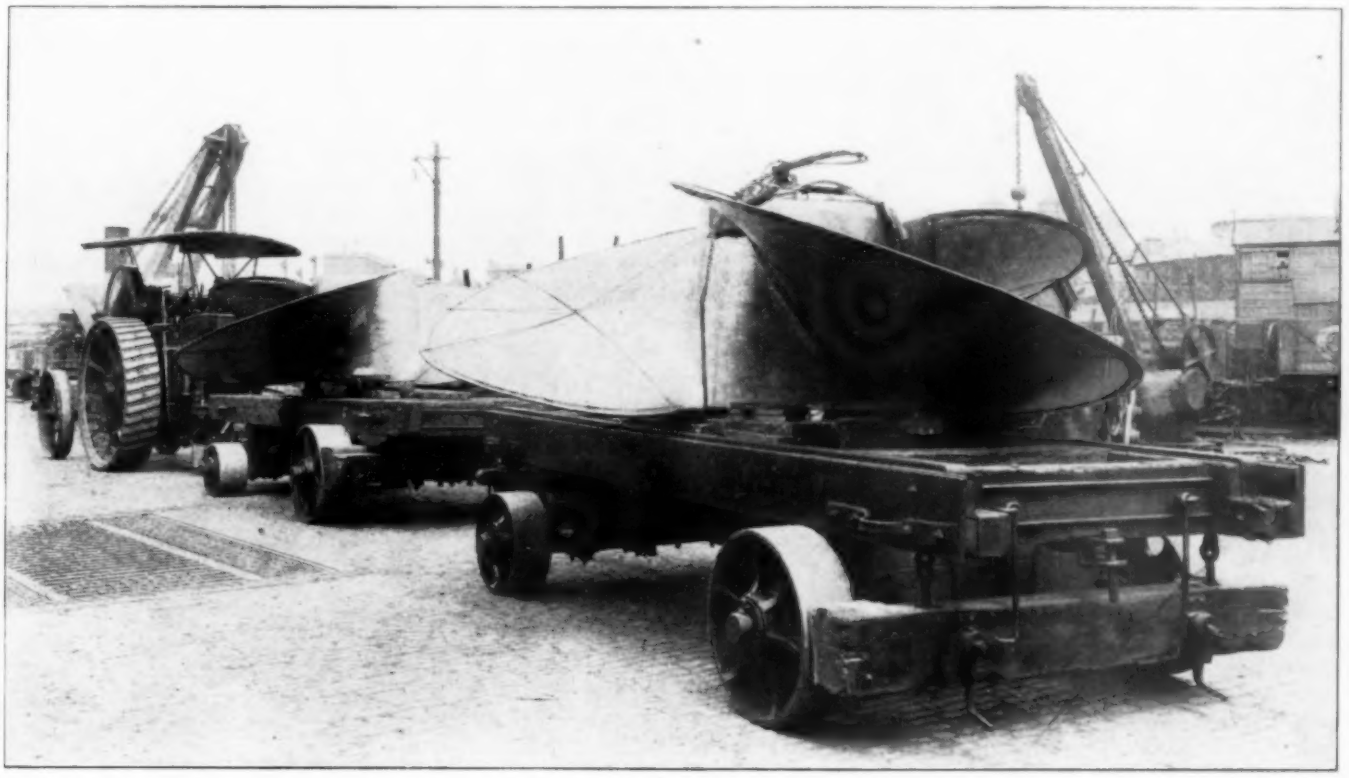


FIG. 15—SPECIAL TRUCKS PULLED BY A TRACTOR ARE USED TO CONVEY THE PROPELLERS TO THE SHIP YARDS

bottom pouring only clean metal is introduced into the mold, and also being raised above the highest portion of the mold, it ensures the necessary head of liquid metal to force the bronze from the bottom of the mold upward to the top of the feeding head above the boss in the case of a solid propeller, and above the flange when casting a single blade.

It is of great importance that the flow of metal from the runner box to the mold should be uniform and unimpeded. Any irregularity or checking of the flow of metal is apt to cause over lapping, that is, layers of metal solidifying independently. Care must necessarily be exercised to guard against the inclusion of dirt, dross and splashings, and all such matter likely to be trapped by the casting must be carefully directed during the casting operation in such a manner that it is all subsequently collected in the discard from the top of the casting.

The mold, having been filled, and any surplus metal discharged, the surface of the metal in the head is skimmed free from dross by suitable skimming irons, and the casting has then to be fed. This feeding is accomplished by use of feeding rods, and by additions of hot liquid metal. In the former method heated wrought-iron rods are moved by hand up and down in the metal in the head of the casting until solidification takes place, the depth of immersion of the rods being lessened as solidification progresses. In the latter method, a liberal supply of hot liquid metal of the same quality as used in the main casting is directly mixed with the metal in the head of the casting. This feeding metal is carried in crucibles direct from small melting furnaces, and its introduction into the head of the casting serves not only for feeding, but tends to liven up the more or less sluggish metal to which it is added, and for this reason should be hot. If feeding is not resorted to, or if the operation is not skilfully performed, contraction cavities or draws will be found in the surface exposed by cutting off the head, and also when boring out the boss.

Feeding the Head

With castings weighing 2 tons and upward the head must be kept liquid for a considerable period, as this portion of the casting must obviously be the last to solidify if it is to perform its full function. Castings of heavy weight are kept open in the head by the addition of 2 or 3 tons of molten metal introduced in quantities of say 500 pounds at comparatively short intervals as may be considered necessary.

When the metal as a whole has set and cooled somewhat, it is desirable to uncover certain portions of the casting in order to prevent distortion by internal stress, and also as a means of controling the thermal treatment during the cooling of the casting. The grain size of the metal is materially influenced by the rate of cooling, and as previously stated, the judicious application of ways and means of accelerating or retarding this rate of cooling, acquired as a result of long experience, plays an important part in ensuring to such castings practical immunity from subsequent failures attributable to casting stresses and abnormal grain growth.

Stripping the Casting

The operation of stripping the hot casing is one requiring great care. Undue haste must be avoided or contraction cracks may develop, and all work must be conducted without shock, as otherwise the metal, being at such a time in its weakest condition, may be seriously damaged. The period during which this thermal treatment is controlled depends upon the weight and bulk of the casting, and two or three days elapse in he case of the heavier castings before the whole mold is stripped from the casting.

The propeller or blade, immediately after removal from the mold, is stamped with the works sequence number to insure its identity being preserved. It is desirable to ascertain and record the weight of the casting complete with head and runner, as such weight, together with the overflow, affords a check on the furnace and casting losses. A test bar, cut from the actual casting, is then removed and tested in order to ascertain that the metal is up to specification. The test proving satisfactory, the casting is cleaned free from all adhering loam and critically examined before being passed on to the chipping room.

Before being sent to the machine shop the propeller casting is roughly trimmed, the runner is removed and any surface excrescences due to cracks in the loam, etc., are removed by chipping. Pneumatic hammers are used exclusively for this class of work.

The works inspection of a finished propeller or blade includes the critical examination of the whole surface for any signs of porosity or cold shuts. All dimensions are carefully checked and recorded, together with any error or distortion of pitch. Such inspection is quite impartial and nothing is concealed from the inspector representing the customer.

The pitch is checked by means of a pitchometer, several readings being taken along lines scribed at each foot, or less, radius on the blade. The inspection also covers the checking of all identity numbers, lettering or wording, including in the case of propellers for the British admiralty, name of ship, maker's name, hand and position, diameter of propeller, pitch, expanded surface. The stamp of the inspector responsible for passing the propeller is placed alongside the markings.

Tensile test bars and bending bars also when required are always cast on the surface of both solid propellers and blades, the position and number of the bars being usually stated on the specification which accompanies the order. These bars are stamped by the customer's representative before removal from the casting and are cut off in the chipping room. After the test pieces are machined they are broken either by the representative himself or in his presence by the works inspector. In some instances the customer is satisfied if furnished with a certificate of test signed by a responsible member of the works inspection staff.

A complete history sheet of each propeller and blade is made and filed. Such a sheet embodies full information relative to the manufacture of the propeller or blade through all the various operations, and affords a ready means of investigation in the event of any question arising at a future time.

Dipper Shovel Is Attached to Standard Crane

To increase the field of use of its excavator cranes, the Pawling & Harnischfeger Co., Milwaukee, has developed a shovel attachment which may be applied to its existing equipment without additional drilling. These cranes, which are operated by gasoline engines, are equipped with caterpillar drive wheel on the rear. As shown by the accompanying illustration, the main parts required to attach the new shovel are a dipper and dipper handle, a boom, a boom foot socket casting, a thrusting shaft, an operation lever bearing, a thrusting chain, a set of boom braces and the necessary operating levers.

The dipper is constructed with a steel plate shell, steel plate front, steel plate lip and door, steel casting back and forged hardened teeth. The capac of the dipper is ½ cubic yard. The boom is constructed of structural steel plates and shapes in the form of a box section and is so designed that all rivets are driven from the outside. Adjustment of the boom is accomplished by steel forging swing braces with turnbuckles. A sprocket loosely mounted on the shaft for operation of the dipper may be rotated in either direction for thrusting out or drawing in the dipper handle. With the exception of the brake attachment, all operations are performed by standard levers.

How and Why in Brass Founding

By Charles Vickers

Excess Phosphorus Causes Holes in Castings

We are having trouble due to porosity and are sending you a sample of metal cut from a casting which is all honeycombed. These castings are valves and the alloy consists of copper, 90 per cent; tin, 9.50 per cent; phosphorus, 0.5 per cent. This is a mixture for acid resisting purposes and must be closely adhered to. We are using part scrap in the mixture, but have tried new metals with the same results, and are at a loss to account for the difficulty.

The trouble with the alloy is that it is too high in phosphorus, if 0.5 per cent phosphorous is being added. However, from an inspection of the sample casting, it appears that 0.5 per cent of a 15 per cent phosphor copper is being used. This makes it 0.075 per cent phosphorous added, which is still too much for this alloy. Use the following alloy:

Scrap And New Metal	
Copper	68.5 pounds
Tin	6.5 pounds
Porous scrap	25.0 pounds
Phosphor copper	none

Use hardwood blocks on the metal while it is being melted, and if the above fails to give sound castings, add 2 per cent zinc to the alloy, or if preferred, use all new metal, but substitute for the 0.5 per cent phosphor copper, the same amount of 30 per cent manganese copper, *A* Grade.

Increasing Strength in Aluminum Bronze

We are making an aluminum bronze containing 90 per cent copper and 10 per cent aluminum. We find the metal shows spots throughout, which look like oxide spots; otherwise the metal seems excellent in texture and under the tool when being machined. We melt in a coal-fired, crucible furnace and cover the copper with charcoal. The aluminum is introduced after the copper is melted and then thoroughly stirred. We would like to learn if the addition of a deoxidizer or a small percentage of another metal would give us a clearer metal. The tensile strength required is 80,000 pounds. We have been advised that ½ pound of iron and ½ pound of manganese copper, containing 30 per cent manganese, in place of 1 pound of aluminum, would greatly benefit the metal.

The aluminum bronze is being made in the correct manner. It is advisable in making this alloy to use high grade copper, because any oxides in the original copper will be reduced by the aluminum with the formation in the bronze of fused inclusions of alumina. A deoxidizing alloy is being used by some makers of aluminum bronze with, it is claimed, great benefit. However, this alloy will not develop 80,000 pounds tensile strength. The addition of the amounts of iron and manganese mentioned will not greatly improve the strength of the alloy. Both manganese and iron are excellent additions to aluminum bronze, but we suggest that more iron than 0.50 per cent be added, as the alloy copper 89 per cent, aluminum 10 per cent, iron 1 per cent cast into small test bars will pull at its best only 70,000 pounds with 20 to 25 per cent elongation. The strictly 10 per cent bronze will rarely reach 70,000 pounds tensile. Usually the tensile strength is about 65,000 pounds in small castings and 10,000 pounds tensile below that in the case of large castings.

Uniting Iron and Brass

We have a cast iron slide 4 inches x 18 inches long upon which we must cast a brass face ¼-inch thick. Please advise us how to proceed in order to get the brass to adhere to the iron.

It will be necessary to retain the brass on the iron by mechanical means as it would be difficult to burn the brass onto the iron. A good way of doing this would be to drill shallow holes into the iron into which the brass could run and thus rivet itself to the iron base. The holes should be larger at the bottom than at the top so the brass can not come out, and it will be necessary to chip out the bottoms of the holes, or to undercut them in some other way.

The iron should be heated to a dull red before the mold is closed and the brass poured, and the brass should be flowed out after the mold has filled. Run out several pounds of brass to insure that the brass will not crack.

Aluminum for Use in Ice Making Machinery

A discussion has arisen regarding the feasibility of using aluminum trays and cups for making ice cubes in the ice-making compartments of the brine tank of an electric refrigerator. We desire to learn if there are any poisonous or injurious salts formed on aluminum during such service, and if so what can be done to remedy this bad feature. It will be understood that no brine comes into contact with these trays, as the brine is sealed within the tank.

The salts of aluminum produced under the circumstances stated would not be poisonous. When exposed to moisture thin coating of hydrated oxides is formed on aluminum. If the aluminum contained magnesium, the coating would be made up of the hydrated oxides of aluminum and magnesium; but if it contained copper, nickel, iron, or silicon, none of these metals would be found in the coating of oxides. The coating in such cases would consist of aluminum hydrate. Neither aluminum hydrate nor magnesium hydrate is poisonous. A brine would attack aluminum more strongly than water. The salts produced by the decomposition of aluminum are not injurious to the same extent as the salts of many other metals. This may be due to the ease with which such salts are eliminated from the human organism. It is remarkable that although aluminum is so common a constitutent of vegetable food, it is not found in the human organism.

Of course, the utensils should be kept clean, in which connection most people know how to handle aluminum, as it is so commonly used in culinary operations. Alum is a salt of aluminum, and this chemical was, and perhaps now is, frequently used to adulterate bread, as it makes it whiter and more puffy. Medical opinion differed as to the effects of this adulterant, but the consensus of opinion favored the idea that it was injurious; that it caused indigestion and other kindred troubles. A loaf of ordinary natural wheat flour will contain one gram of silicate of aluminum per pound. This is natural to the

wheat, and is added by the wheat. Evidently, therefore, this salt of aluminum cannot be regarded as poisonous.

Aluminum has been found to be a valuable metal for parts of dairy apparatus, and investigation has determined the salts formed on the aluminum in this work are entirely harmless. For making ice cubes, aluminum would appear to be the metal to use.

Overcoming Troubles in Big Brass Bushings

We have experienced trouble making brass bushings, averaging from 1 to 44 pounds each. We have mixed and molded brass for years, and would not call these dirty castings. They come with small blow holes or bubbles in them, but on the outside look as good as ever. When the first cut to finish is taken, the holes appear. We have tried different mixtures with no better result. We are using now 85 per cent copper, 5 per cent tin, 5 per cent lead and 5 per cent zinc, to make one hundred pounds. Then we add 25 pounds of good scrap valves. We think the sand has been used previously for molding castings of iron, and we have been told that when brass is cast in sand that has been used for iron, the castings come filled with blowholes.

It is doubtful if this difficulty with blowholes is due to the sand used in molding. The fact of its having been first used for making iron castings cannot be blamed for the holes. If there is any sea coal left in the sand, all it would do to the castings would be to give them a dark or blackish external color. It would do no further harm because heavy brass castings are being made every day, using sea coal facings. In fact it is necessary for heavy brass as for iron. While there have been no scientific tests to determine the point, using common sense we would brand the story of blowholes being caused by iron being previously cast in the sand, as a superstition having no foundation in fact.

Should iron get into the brass it will not cause blowholes. It will prevent blowholes because it will act as a deoxidizer of the copper. Look for some other cause for these holes.

To eliminate the sand from consideration, answer these questions:

Does the sand produce good iron castings, or does it blow and cut and scab? It will produce the same results with brass as for iron.

Are the molds rammed any harder for brass than for iron?

Another superstition found among iron molders is that molds for brass must be rammed harder than for iron. This is wrong. The molds must be rammed about the same, for if rammed harder they will blow.

However, the fact that the castings on the outside look clean, and that it is after cutting into them that the holes are found, shows the sand is not at fault. If it is not the sand that is to blame, it must be the metal and as the only operation the metal has gone through is to melt it, the difficulty will be found in the method of melting. The following questions must be asked and answered:

Is the coke higher in sulphur than ever before? Is charcoal being used on the metal while it is melting? Is the melter a new man? How are the pots charged? Is a little metal put in and allowed to wilt down, when more cold metal is thrown in and so on until the pot is filled? Is there much phosphorus in the metal or none at all?

Answers;—If there is much sulphur in the coke, use plenty of charcoal and mix in some salt. If charcoal is not being used, it is necessary to procure some right away, or else use hard wood blocks which will burn to charcoal on the melted metal. If the melter is new at the work, pay particular attention to him until he has learned the need for carefullness. Try to charge all the metal into the pot at once. Do this by putting a ring or deepener, on top of the pot. Make this ring from an old pot by chopping off the bottom with a hatchet. Charge all the heat into the crucible and the deepener and put the charcoal on top, then melt quickly, stir and if no phosphorus is being used, stir in a piece of phosphor copper, the size of a walnut, no larger. If there is a large amount of phosphorus in the metal, it will have to be diluted with new metal for this alloy, otherwise the castings will be spongy.

Bronze and Aluminum Data

We desire a mixture for phosphor bronze bearings, and another for an aluminum alloy that will machine easily. Also we desire to learn the mixture for Government G bronze.

A high grade mixture for phosphor bronze bearings is: copper, 75.00 per cent; tin, 11.00 per cent; lead, 9.00 per cent; phosphor copper, 5 per cent. The phosphor copper should contain 15 per cent phosphorus in this formula. An aluminum alloy that will machine well follows: aluminum, 81.5 per cent; zinc, 15 per cent; copper, 3 per cent, and manganese, 0.5 per cent.

The specification for Government *G* bronze follows: Copper, 87 to 89 per cent; tin, 9 to 11 per cent; zinc, 1 to 3 per cent; iron allowable, 0.10 per cent; lead allowable, 0.20 per cent. This alloy must show under tensile test an ultimate strength of not less than 30,000 pounds per square inch minimum; a minimum yield point of 15,000 pounds per square inch, and an elongation in 2 inches of at least 15 per cent.

Bronze Spring Mixture

We have been asked to furnish spring bronze and any information you may furnish us in regard to formula and method of handling will be appreciated.

Brass or bronze is made springy by rolling or drawing; when cast it will have little if any spring. Yellow brass mixtures containing a little tin and iron are best suited for spring making. Bronze mixtures containing phosphorus or manganese also give good results.

The following phosphor bronze is frequently used for making metal that works as a spring: Copper, 94 pounds, 11 ounces; tin, 5 pounds; 15-per-cent phosphor copper, 5 ounces. A little harder mixture follows: Copper, 92.5 pounds; tin, 7 pounds; manganese copper 0.5 pound.

Aluminum and Sand for Cooking Utensils

We are making aluminum cooking utensils and are seeking information regarding the mixture of metal and the kind of sand to use for the molding.

Practically every known alloy of aluminum has been used to produce cast cooking utensils. Theoretically, the purer the aluminum the better, but in fact, alloys of aluminum and zinc with or without copper are used extensively. The objection to such alloys is that they blacken and it is difficult to clean them. A No. 12 alloy can be used. This consists of aluminum 92 per cent, copper 8 per cent, also the following alloy is applicable:

Aluminum Alloy	
Aluminum	95.50 per cent
Copper	1.50 per cent
Nickel	1.50 per cent
Magnesium	1.50 per cent

Use a grade of sand that is fine enough to get smooth castings; but see that the sand is also free venting. Suitable sands for aluminum are found in Ohio. An important matter is to so proportion the metal thickness of the utensils that the aluminum can be poured at a moderate temperature.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

ANALYSES OF TIN

The samples of tin, the analyses of which are here presented, were secured through the efforts of W. A. Cowan, National Lead Co., Brooklyn, N. Y., and are reported by him in a paper presented before the American Institute of Metals. For sampling, the whole original pig was melted in a small clean kettle to a temperature of about 280 degrees, Cent., (536 degrees Fahr.). The molten tin was thoroughly mixed by stirring, then poured into thin bars in a cold mold, in order to set the metal quickly and with as little segregation as possible. The thin bars were cut in two and several pieces sent to each analyst, no two halves of the same bar being included in any one set of samples. These samples were prepared for analysis by sawing the bars entirely through in a number of places evenly distributed throughout their length, with a carefully cleaned hacksaw blade, then passing a magnet through the sawings to remove any particles of steel. A second method of obtaining samples was to roll the bars into a thin ribbon of foil, after removing any surface contamination, and to cut sections representing a fair sample of the whole length of the ribbon. A third way of sampling, was to file complete cross sections at the ends and in the middle of each bar with a coarse rasp and treat the filings with a magnet.

Each analysis was made by a different chemist. Analysis *A* was made by the American Sheet & Tin Plate Co.; *B*, by Ledoux & Co.; *C*, by A. H. Knight; *D*, by National Lead Co.

PYRMONT (AUSTRALIAN) TIN

Impurity	A Per cent	B Per cent	C Per cent	D Per cent
Lead	0.019	0.045	0.016	0.055
Arsenic	0.020	0.035	0.019	0.088
Antimony	0.054	0.074	0.041	0.098
Copper	0.023	0.027	0.015	0.024
Cadmium	....	None	....	None
Bismuth	....	0.010	0.007	None
Iron	Trace	0.003	0.003	0.003
Zinc	Trace	....	....	0.01
Nickel & Cobalt	....	None	None	None
Manganese	....	None	....	None
Tungsten	....	....	....	None
Sulphur	Trace	....	Trace	Trace
Phosphorous	Trace	None	None	0.020
Tin (by diff.)	99.884	99.806	99.966	99.762
	100.000	100.000	99.977	100.000

(*Continued on Data Sheet No. 382*)

ANALYSES OF TIN

(*Continued from Data Sheet No. 381*)

BANCA TIN

Impurity	A Per cent	B Per cent	C Per cent	D Per cent
Lead	Trace	0.010	Trace	Trace
Arsenic	0.024	0.004	Trace	None
Antimony	0.038	none	0.006	0.006
Copper	0.003	0.009	0.002	0.004
Cadmium	....	None	....	None
Bismuth	....	0.002	None	None
Iron	Trace	0.004	0.023	0.019
Zinc	Trace	....	....	Trace
Nickel & Cobalt	....	None	None	None
Manganese	....	None	....	None
Tungsten	....	....	....	None
Sulphur	Trace	....	Trace	Trace
Phosphorous	Trace	None	None	0.008
Tin (by diff.)	99.935	99.971	99.963	99.963
Total	100.000	100.000	99.994	100.000

STRAIGHTS SETTLEMENTS TIN

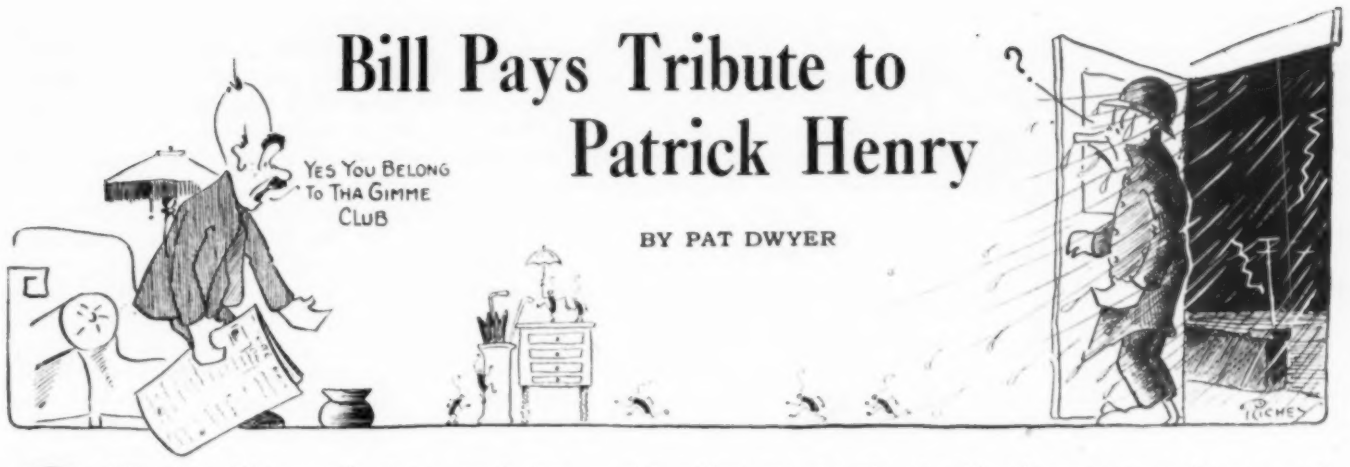
Impurity	A Per cent	B Per cent	C Per cent	D Per cent
Lead	0.057	0.080	0.049	0.064
Arsenic	0.084	0.072	0.058	0.077
Antimony	0.103	None	0.018	0.018
Copper	0.013	0.027	0.020	0.020
Cadmium	....	None	....	None
Bismuth	....	0.003	0.004	None
Iron	Trace	0.005	0.003	0.005
Zinc	Trace	....	....	0.015
Nickel & Cobalt	....	None	None	None
Manganese	....	None	None	None
Tungsten	....	....	....	None
Sulphur	Trace	....	Trace	0.009
Phosphorus	Trace	None	None	0.010
Tin (by diff.)	99.743	99.813	99.831	99.782
Total	100.000	100.000	99.983	100.000

(*Concluded on Data Sheet No. 383*)

Note—This sheet may be cut into two sections 5 x 7 inches, and may be readily bound in note book form.

Bill Pays Tribute to Patrick Henry

BY PAT DWYER



ONE rainy night recently about 11 o'clock while I was debating in my own mind whether to take a little nap in a perfectly comfortable chair or to go to bed like a Christian, I heard some person fumbling with the door knob. With a mental malediction on visitors in general and in particular on those who go prowling around in the dark hours of the night, I opened the door and admitted Bill who told me that he was on his way home from a meeting of the Ancient and Oriental Order of Immortal Star Gazers. He said that he had observed the light in the window and had called in, partly for the sake of paying a friendly visit and partly for the sake of borrowing an umbrella. He hastened to add that so far as he was concerned he did not care whether the umbrella was mine or not. He marveled at finding me alone and said he could not understand how a person could be satisfied to sit all alone without any company. I told him that I liked to sit up for an hour or so after the family had retired. It was the only time during the day that I felt I was my own master to do just as I pleased. I had to watch my step all day and I enjoyed this hour of perfect liberty when I could do as I pleased and revolve in my mind many of the things I should have liked to have said during the day.

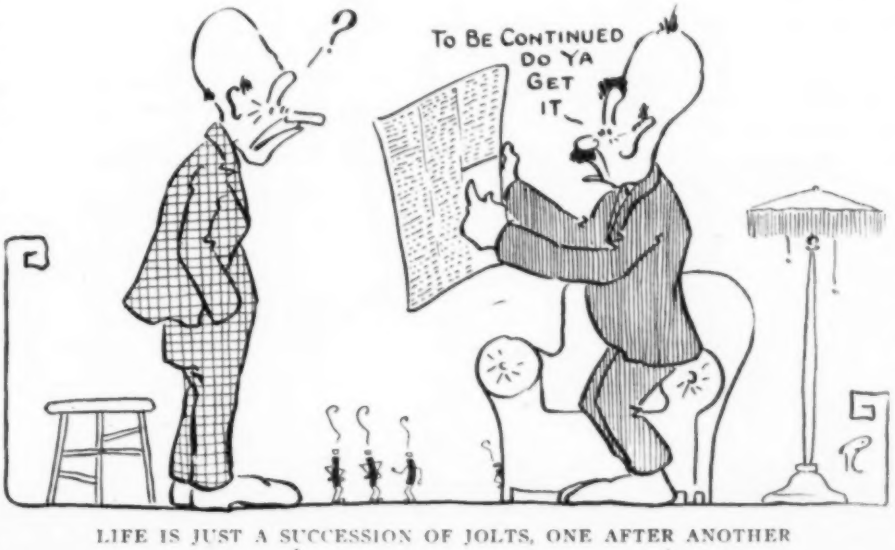
"Well," said Bill, "I don't know but what you are right. I often feel that way myself. In common with all liberty loving men, (and where is the man who does not love it?) I appreciate the pleasure and privilege of indulging in free speech. For further particulars on this subject see the life and adventures of the famous Virginian who founded the Gimme-Gimme club. Standing on the floor of the Virginia convention, with one hand under his coat tails and the other pointed accusingly at the speaker he shouted—of course you understand I simply am quoting from memory,—the immortal words: 'Gimme liberty or gimme death'!

"A study of contemporary history would seem to indicate that he was a persevering kind of a bird for he finally achieved both objects of his ambition. On the first point some slight doubt is permissible, inasmuch as Mr. Henry was a married man and liberty after all is a relative term; but on the second point I think I am quite safe in saying that public opinion practically is unanimous at the present day. If he is not dead then all I have to say is that there is one undertaker who will have a heavy score to settle some day.

"You hear a lot about Solomon, what a wise lad he was an all that kind of thing, but as I grow older I sometimes question the wisdom of some of the sayings credited to his account. For instance in Proverbs XV-1 we read that 'A soft answer turneth away wrath, but grievous words stir up anger.' Now I leave it to you as a reasoning human being, whether it is more conducive to peace to suffer the humiliation of spirit essential to the proper framing of a soft and gentle answer or to stand up and meet the attack like an officer and a gentleman. Of course, in these modern days that old phrase coupling an officer and a gentleman does not mean anything, but you know what I mean.

"Two things that never fail to peeve me, nay three, as Solomon says elsewhere in his book, are: First the necessity at times of framing a soft and gentle answer when I really feel like saying something that would blister the hide on the party of the second part. Second to pick up a magazine and after having read 30 or 40 pages to be brought up standing with the line, *to be continued*. Third, starting to tell a story and then having to stop before I have finished. On two former occasions I discussed some of the features in connection with making the sand bed for an open sand mold and on each occasion I had to stop before I had said all I wanted to say. I wish to make a few more remarks before disposing of the subject and the present occasion seems as favorable as any other. Hearing no objection from any of the members present, let's go.

"The fact that the radius of a circle is equal to one sixth of the circumference when measured in a straight line is taken advantage of in many ways when laying out certain definite points on a circular open sand plate. For instance if six holes are required spaced equidistant it only



LIFE IS JUST A SUCCESSION OF JOLTS, ONE AFTER ANOTHER

is necessary to scribe a circle the required distance from the center, then take the trammels and step them around on this circle. Similarly if three equidistant points are needed, every alternate mark of the six is selected; while if 12 points are desired it is a relatively simple matter to subdivide the six spaces.

"Trammels have been mentioned in connection with these different operations because they are available in practically every foundry, especially in those having a pattern shop in the immediate vicinity. However, where no pattern shop is convenient, or where a man is in a hurry, or does not care to borrow a pair, a substitute easily may be improvised by measuring the desired radius on a long narrow stick and then driving nails through the stick at two points, one nail to serve as a center and the other as a marker.

"To lay out the position of the four lugs usually provided on a circular lifting plate, a long straightedge is laid on the bed, one edge passing directly over the center mark. The point of the trowel is employed to make a mark passing through the center and cutting the circumference at two opposite sides.

"The straightedge then is lifted and set down again at right angles to this line. A steel square is employed to adjust the straightedge so that it forms a 90-degree angle at each side. The edge, of course, is held closely on the center as in the first case. A mark scribed in the sand alongside the straightedge will be at right angles to the first line and the points where it cuts the circumference will be equidistant from the marks already established.

"When setting on these marks the blocks designed to form the handles it is optional whether the center of the block is placed over the mark or whether one side of the block is made to coincide with it. If the latter course is adopted care must be exercised to see that the block is set in the same relative position at each mark. Thus, if the block is set on the right hand side of the first one it also must be set on the right hand side of each of the remaining marks.

"Where the size and shape of the lugs or handles are to conform to a definite standard, it is necessary to provide a block of the desired shape; but in ordinary foundry practice where these features are of no relative importance, one or two bricks will be found quite satisfactory as patterns. They are rather rough but they can be rapped sufficiently to enable the molder to draw them out of the sand. In fact, for large plates, especially those used in loam molding, it is customary in many shops to dispense with segments altogether. A dozen or more bricks are set with their outside edges coinciding approximately with the circle marked on the sand bed. Sand is banked and rammed against them, after which they are moved to a new position and the operation continued until the entire ring has been enclosed.

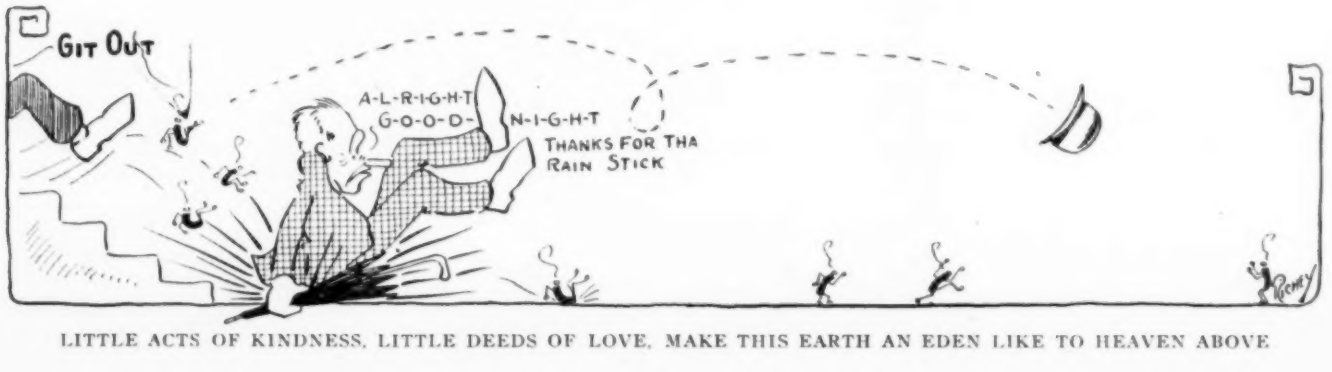
"In many open sand plates, it is necessary to provide openings for various purposes. If intended merely as vent holes, pieces of coke or scrap cores are pushed into the face of the sand bed. They are left protruding above the bed sufficiently to insure that the molten iron will not cover them and at the same time they are pushed into the sand a sufficient distance to anchor them firmly and preclude the possibility of their being dislodged either by the force of the stream of iron or from their own buoyancy when immersed in the molten iron.

"When holes of a definite shape are required, the position first is indicated on the bed and then the necessary cores, either dry or green sand are set in place. If dry sand cores are employed and merely set in position on the sand bed it will be necessary to place a small weight on each one to prevent it from floating away, when the mold is filled with iron. If an open frame corebox is available, green sand cores are to be preferred. The open frame is set over the space to be occupied by the core, it then is filled with molding sand and rammed. It may be necessary in some cases to drive a few nails, rods or soldiers in the core to anchor it to the bed, but in the great majority of cases this precaution is unnecessary.

A LITTLE SESSION OF THE GRAND OLD INDOOR GAME,—CHEWING THE RAG

"Before leaving the subject of open sand plates, it will not be amiss to say a few words about pouring them. The lip of the ladle should be brought as close to the pouring basin as it would be if the basin was arranged on the cope of a closed mold. Dropping the iron from any considerable height will cut away the sand forming the basin and result not only in a dirty and unsightly casting, but, in case the basin breaks away under such treatment, in a spoiled casting.

"Small plates usually are high enough above the floor to permit the ladle to be lowered down back of the basin, but in the case of large plates which usually are molded flush with the floor it is necessary to dig a pit back of the runner in which to lower the ladle. The basin should be dished out near the



LITTLE ACTS OF KINDNESS, LITTLE DEEDS OF LOVE, MAKE THIS EARTH AN EDEN LIKE TO HEAVEN ABOVE

back and the first iron should be poured gently until this basin is filled. A common fault among the inexperienced is to make the basin too short, with the result that the stream of iron falling close to the edge of the mold cuts away the corner and makes an unsightly mess at that point. After the basin has been filled, the ladle is tilted rapidly until the iron has reached the farthest side of the mold, it then is checked and a small stream poured to meet the returning wave. The speed of pouring is alternately accelerated and retarded to meet the fluctuations of iron in the mold until the required thickness has been reached.

"A moment's reflection will convince any person that there is a vast difference between preparing a bed for an open sand plate and preparing a bed for a mold that is to be poured under a cope. The open sand bed has only to support the weight of the thickness of iron lying on top of it, while the bed of a closed mold has to support the weight of iron lying on the bed multiplied by the height of the pouring basin. Thus a plate 12 inches square and 1 inch thick would only exert a pressure of 12 x 12 x 0.26, or 37.44 pounds on an open sand bed; but would exert a pressure of 12 x 12 x 0.26 x 6 or 224.64 pounds on the bottom of a mold if it was covered by a cope 6 inches high.

"The same rule applies to a plate of any area, that is the area in inches multiplied by the height of the pouring basin in inches, multiplied by 0.26, the weight of a cubic inch of cast iron, will give the pressure in pounds on the bottom surface of the mold. The same rule will give the pressure exerted against the face of the cope and indicate the amount of weight required to hold the cope down and prevent the iron from finding its way out at the joint of the mold. In the first instance, the height is computed from the bottom face of the mold to the top of the pouring basin or the riser if the mold is provided with one; and in the latter case, the height is reckoned from the under face of the cope to the top of the pouring basin or riser. An application of this rule is found in the practice of providing a low riser or flow off to reduce the pressure against the cope in cases where it is necessary to use a high pouring basin.

"For the reasons set forth it is evident that the bed of a closed mold must be made much harder and firmer than a corresponding bed for an open sand mold. The soft sand under the face of an open sand mold is open and porous enough to conduct the steam and gas away from under the iron without the aid of any artificial venting, but the bed of a closed mold on account of its increased density must be vented with a wire and some provision made underneath to carry away the accumulated gases.

"The usual procedure in such cases is, first to lay a cinder bed connected with the open air either by one or more pipes if the mold is made in the floor; or by an open space between the lower edge of the drag and the bottom board or plate if the mold is made in a flask.

"Assuming that the cinder bed comes to within 4 inches of the face of the mold, black sand is shoveled in to that depth and tramped off. This will result in lowering the sand about an inch. The face is then gone over with a vent wire making sure that the point of the wire reaches the cinders each time it is driven down. Facing sand to a thickness of about 1½ inches then is spread over the bed and tramped off lightly. A long straightedge with the ends resting on opposite sides of the flask or on the two straightedges, depending on whether the mold is made in a flask or in the floor, is employed to scrape the facing sand off flat.

"If necessary, small excavations are made in the bed to accommodate any inequalities in the face of the pattern. These depressions are lined with facing sand to approximately the correct shape, after which the pattern is lowered into place and rapped all over to secure a firm impression. It may be necessary to lift the pattern out again and add a little facing sand here and there to fill up any soft spots. The pattern then is returned after which the ramming of the remainder of the mold proceeds in the usual manner.

"In earlier works on foundry practice, it has been pointed out that the vent wire should not be used until after the facing sand had been tramped down and scraped off. The holes then are stopped up with the finger and a small quantity of facing sand. This is a time consuming process and is not necessary. If a fine grade of sand is employed it may be necessary, but shops engaged in making large castings usually employ an open grade of sand and if they do not it will pay them handsomely to secure a supply. Except for fine, light work a fine grade of sand is a delusion and a snare. It requires the most careful and delicate handling and if not copiously vented will produce more scrap than good castings."

"Bill," I said, "I have listened at least with patience if not with pleasure and profit to your serial story on the preparation of beds, but strictly among ourselves and with no idea of shirking the sacred rites of hospitality by turning you out in the cold and the rain. I must confess that the only bed that interests me at the present time is the little one upstairs where I should have been an hour ago."

"The idea," said Bill, "of a grown man going to bed at an hour like this! The next thing I expect you to tell me is that you sleep in a crib with a little teddy bear held tightly in your chubby little fists, *Good Night.*"

Molds Made from Match Plate Are Shifted

Question: We should like to have your advice on the trouble we are having with a match plate for small cupboard door knobs. The plate was made to use with a 13 x 17-inch flask. The trouble seems to be in the mold made from the match plate and not in the plate itself. We are unable to get two molds exactly alike. In one mold the one outside row of castings will show a shift while all the remainder are perfect and in the next mold both outside rows of castings on opposite sides of the plate will be shifted while those in the center are alright.

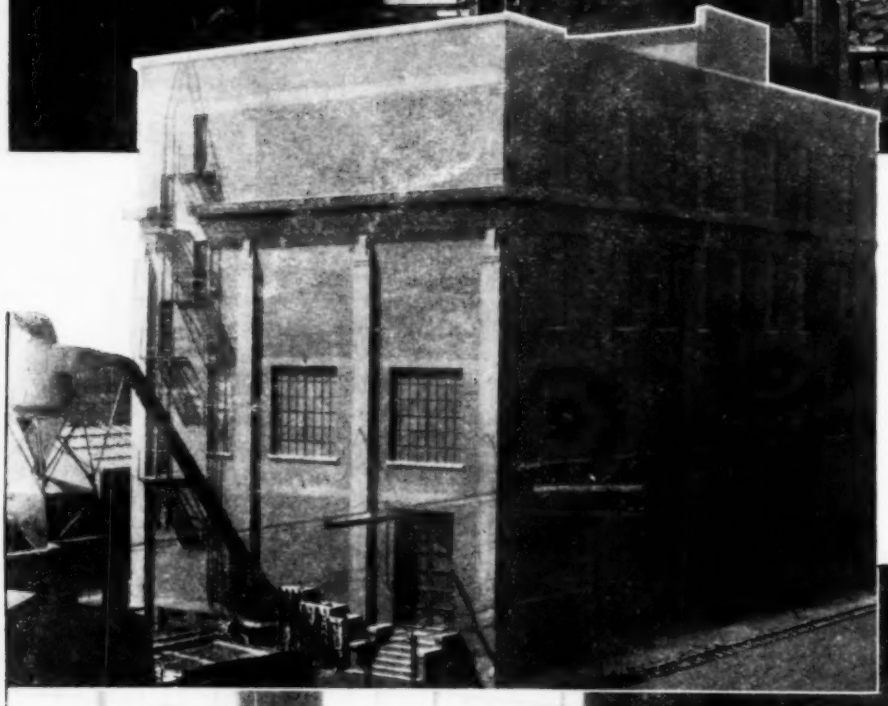
We have hand rammed some of the molds and have squeezed others and also have made two match plates, one straight and the other crowned, but without result. The flask pins are straight and there is no shift in the plate or snap flask pins. Could it be that the mold is too large which allows it to sag? We hope that you may be able to suggest a remedy and assure you that it will be greatly appreciated.

Answer: Without actually seeing a mold made and poured we could not say definitely just what is the trouble. Several factors which might affect the job have not been touched upon in your inquiry. However, it is probable that the fault can be traced to an ill fitting jacket or to the fact that no jacket is employed to contain the body of sand forming the mold after the snap flask has been removed.

If the two outside rows of patterns approach closely to the sides of the flask, the pressure of the molten iron will force the sand more or less out of shape if it is not reinforced by a close fitting jacket or band. To determine the cause of your trouble we should suggest that you make a mold and pour it without removing the snap flask. If the castings produced in that manner are perfect it is quite evident that your molds need support before they are poured.

Small flasks are more satisfactory than snap flasks but if you wish to continue using the snap flask you will have to drop a band inside each half of the flask before it is rammed full of sand to prevent distortion.

Efficiency in Operation and Safety



ALL THE PATTERN WORK IS CONCENTRATED IN ONE BUILDING, WITH HEAVY STORAGE IN THE BASEMENT, THE CARPENTER SHOP ON THE FIRST, THE PATTERNSHOP ON THE SECOND AND LIGHT STORAGE ON THE THIRD AND FOURTH FLOORS

...in Storage Secured in New Building

BY GEORGE H. MANLOVE

SAFE and efficient storage of foundry patterns always has been a problem. Recent carefully designed installations seem to solve the difficulties and to house the patterns in a way to meet all requirements. The ideal pattern storage system provides safety from fire, renders every pattern instantly accessible, and is flexible through the use of adjustable shelves so that patterns of any size can be accommodated. The new pattern storage building recently built by the Whiting Corp., Harvey, Ill., for its own use, was constructed with these precepts in mind.

The new building forms the keystone of the foundry group, being in an angle flanked on the one side by the foundry, on another by the core room and sand storage bins, while the flask yard is on the third side. The space between the new pattern storage and other foundry buildings has been roofed over, making the lower floors practically continuous. A system of narrow gage tracks with turntables gives immediate access from the pattern building to the core room and foundry while a monorail in the carpenter shop passes through a door leading to an extension of the industrial track by which flasks are handled to and from the flask yard and also to the foundry.

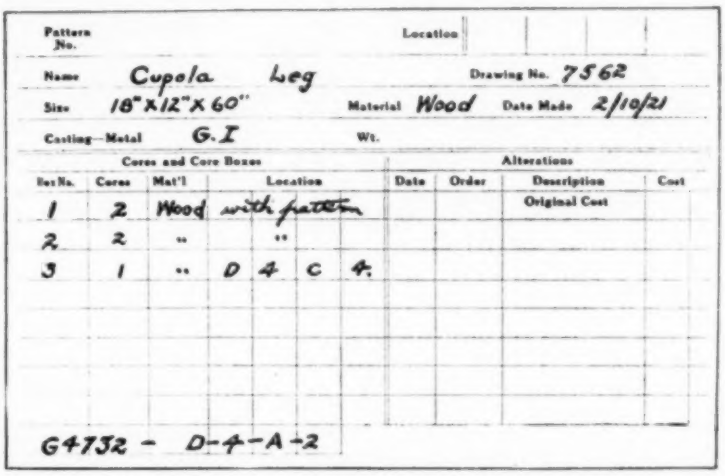
On the elevator connecting the various floors is a grooved track matching the narrow gage track in the foundry, and this is continued across the first floor to about its center where it terminates directly under the monorail. All transportation inside the building is by flat wheel trucks, but from this building to other buildings it is by flanged wheels on T-rails.

The building 56 x 96 feet, with a basement and four floors. The basement has a 9-foot ceiling, and the other floors each 14-foot ceilings. The structure is of reinforced concrete construction, with face brick panels. The only wood in the entire building is a hardwood floor laid directly on the concrete in the pattern shop. The building is fully equipped with sprinklers, hand extinguishers, a truck extinguishing tank and regulation fire hose. Fire doors equipped with fusible links, and the metal sash, wireglass windows still further decrease the fire hazard.

The basement has been provided with fixed racks for the storage of heavy patterns for which there are few calls. The first floor is devoted to the carpenter shop and pattern lumber storage, the second floor to the pattern shop, and the third and fourth floors to pattern storage.

The latter are probably the most interesting parts of this installation. Each floor is filled with steel filing racks from the main floor to within a prescribed distance of the sprinkler system, and at seven feet from the main floor a mezzanine floor of the subway type is carried by the racks. This floor is in sections and does not touch the walls of the building except at the elevator entrance. These subway floors in effect make four stories of the two devoted to pattern storage. Each mezzaanine floor has its own entrance from the stairway and elevator, its individual switchboard for its own lights and complete fire protection.

Each floor has 44 racks arranged in two series, with a central aisle. Each rack has from four to seven sections and each section has from three to six shelves. The variation in sections and shelves is due to the requirements of different sized patterns.


Pattern No. — Location

Name: Cupola Leg — Drawing No. 7562

Size: 18"X12"X60" — Material: Wood — Date Made: 2/10/21

Casting—Metal: G.I — Wt.

Cores and Core Boxes

Box No.	Cores	Mat'l	Location	Alterations: Date	Order	Description	Cost
1	2	Wood	with pattern			Original Cost	
2	2	"	"				
3	1	"	D 4 C 4				

G4732 - D-4-A-2

PATTERNS ARE REGISTERED ACCORDING TO THE LIBRARY SYSTEM

The system followed in filing patterns is simple and efficient. Each pattern is given a designation consisting of two letters and two numbers, placed alternately. These designations are stamped in wood of the pattern to prevent identity being lost. The letter designates the floor, the first number the rack, the second letter the section and the second number the shelf. Thus, D-4-A-2 would indicate floor, D, rack 4, section A, shelf 2. With this system it is a comparatively easy matter to find any designated pattern. For the same reason it is easy to stow them away.

The card forms such as that shown in the illustration are filed on flat racks, each containing 200 cards, in the order of the pattern number. Thus, when an order comes from the production department to the foundry for certain patterns reference to the index under the pattern number shows its location in the storage. On the card is number of core boxes and their location. In some cases core boxes are placed with the pattern, but inasmuch as frequently a set of core boxes are used with two or more patterns, reference must be given it where they are placed. On the reverse of the card is provision for record when patterns are shipped away from the shop and also means for indicating the number of trips each pattern makes to the foundry.

When the order has been completed and the patterns are returned to storage, the reference number stamped into the wood indicates instantly their proper disposition without reference to the index.

Capacity of this building is about 20,000 patterns. They have been removed from four separate buildings at this plant, properly classified, stamped and filed away.

The pattern shop, occupying the entire second floor, has been designed with every convenience and comfort. Except for the concrete columns, the walls of this shop are glass on all sides, giving a maximum of illumina-

(*Concluded on page 40*)

Die-Casting Methods and Metals-III

Methods of Placing Inserts in Die-Castings—Cleaning Baths Are Recommended and Details of Electroplating Process Are Described—Brass Deposited in the Same Manner as Copper

BY M. H. POTTER

WHEN the metal of which a die casting is to be made is not suitable for certain parts due to the functioning of such parts, an insert of some other suitable metal or material may be placed in the die and metal cast around it. Such inserts increase the cost of die castings, as the time needed to handle them in the dies delays production. On the other hand they may make otherwise difficult pieces simpler and less troublesome to cast, or may replace more expensive metals with cheaper ones, in which cases the cost is reduced. Much depends on the design of the part and the location of the insert, which may be so inaccessible in the die that it would be cheaper to drive or screw it into the part after it is made.

Inserts, whenever possible, should be embedded entirely in the metal to strengthen or reinforce the casting. The surface of an insert does not alloy the casting. Therefore the insert would fall out if enough of the casting is removed to release its grip on the insert. Consequently the insert really makes the surrounding walls of a given section so much smaller and thinner. Then when strains and stresses are applied to them they are more likely to break or crack and tear away, exposing the insert. If the strains could be taken up by the insert without first passing through the surrounding walls the case might be different.

Inserts must be large enough to be handled easily by the die-casting machine operator who wears one and sometimes two gloves on each hand for protection from the heat. That part of an insert which is embedded in the casting should be knurled, roughened or so shaped that the metal in shrinking will hold it in place without depending on shrinkage pressure alone.

Some part of an insert, sufficient to hold it in the die, must always be exposed. It could not *float* in the die, as then its location could not be controlled. Inserts should be accurate. Pins or studs fitting into the holes in the dies must fit properly. If they are rough and have burrs they will wear the dies away. Frequently the inserts are so placed that the dies close upon them. In such cases, if they are too large they may seriously injure the die. If too small, the die will not grip them securely and the inrushing metal will shift them.

It is advisable to avoid the use of inserts so placed that the metal will shrink away from them instead of to them, as for instance an insert forming the outer wall of a casting. Hardened or tempered inserts may be used without injury except in aluminum castings. When a special bearing surface to provide for excessive wear is needed, bronze, steel, or graphite bushings may be cast in.

If this stock is used it is preferable to cut grooves in such bushings, instead of knurling them, as knurling will spread them and distort them out of true. Oil holes in inner bushings should be drilled afterward if possible, because of the difficulty of lining up core pins to fit such holes. The delay in production usually amounts to more than the cost of drilling.

When bushings must line up with other parts in an assembly or must fit perfectly, the better practice is to allow 0.005 or 0.010 inch for reaming after the castings are made. A cheap and effective bushing may be formed of sheet brass or steel in one or two operations. It should be left with the seam open. Bushings should be accurate and smooth, to fit the dies and prevent excessive wear.

Expose Part of Insert

A sufficient part of such inserts must always be left exposed to permit the die to properly hold it in place. When the design does not permit this it is sometimes necessary to cut off the insert after the casting is made. The portion of the insert embedded in the casting, commencing about 1/16-inch or more below the surface of the casting, should be knurled, flattened, grooved or squeezed to provide a better grip. The method adopted will be dependent on the character of the die-casting metal to be used. When studs are cast into a wall, the opposite side of which is to be polished or finished, a better appearance will be presented if the base of the stud is pointed to prevent its showing through on the surface, as suggested in the accompanying illustration.

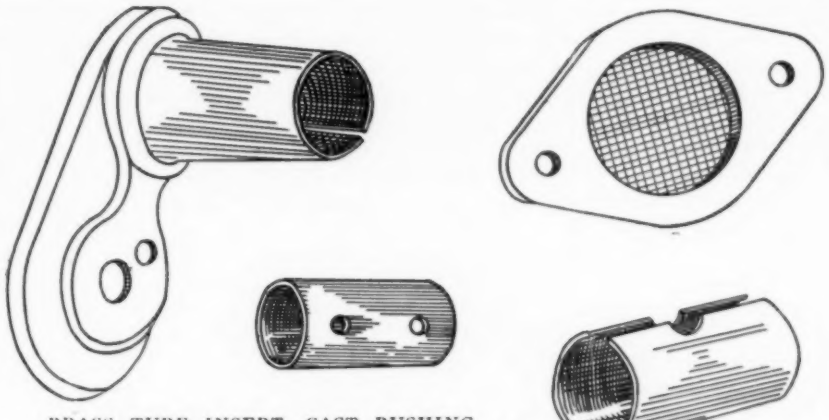
Springs may be inserted in die castings of metals except aluminum without drawing the temper. Springs are usually anchored by punching holes in them. In some cases eyelets are punched into the holes of the springs to give a better hold. Springs 0.003 to 0.0005-inch thick should not be over ½-inch in width as otherwise the metal in shrinking will *jucker* them.

Tubing may be used when the design calls for long, thin walls which cannot be cast. It is sometimes used for its strength, or to afford a passage for corrosive liquids. It may be bent in any shape and used as an oil passage, following an irregular line through the casting. It is advisable to extend tubing, into which cores cannot be fitted, beyond the surface of the casting to prevent the tubing from being filled with metal. Also, such tubes usually must be braced with pins in the die, which are withdrawn when the casting is made but leave holes in the casting up to the outside surface of the tube.

When flat plates are inserted and exposed on one face only, it is necessary to hold them in the die with cores or pins running to the face embedded in the casting. These cores, when withdrawn, leave holes in the casting. Disks should be countersunk and perforated to permit the metal to grip them.

All metal parts before the application of any finish must be thoroughly cleaned and all foreign matter removed from the surface, to permit the coating to come in direct contact with the metal. The usual methods of cleaning die-castings for electroplating baths will be dealt with under the subject of electroplating die castings. For lacquered, enameled and similar finishes, the castings may be washed in hot soapy solutions. Any mild cleanser may be used after which the parts should be thoroughly rinsed in water of the same temperature as the cleaning bath, then washed in water at room temperature and thoroughly dried. All finishes which are apt to discolor or corrode, or which are easily brushed or worn off should be protected with a metal lacquer or varnish. A good lacquer commonly used is made by dissolving 1 ounce of cellulose nitrate in a quart of amylacetate and thinning the mixture with grain alcohol mixed with ether.

After cleaning, the parts may be sprayed with an air brush or dipped in lacquers and enamels, which need not be baked. Cold enamels usually have a cellu-



BRASS TUBE INSERT, CAST BUSHING DRILLED FOR ANCHORAGE, WIRE MESH INSERT AND SHEET BRASS BUSHING

loid base. Best results are obtained if a filler is first applied. The filler gives the work a richer tone and also is more adherent, thereby making the enamel stick better. A filler usually takes about an hour to dry and then the enamel, which is generally first thinned, may be applied. This will dry in about one-half to two hours, according to the material used. Materials for this finish may be secured from several of the larger paint manufacturers.

Baked enamel is applied to die castings in the same manner as to other metals. In all cases, except aluminum, the castings must not be heated to more than about 250 degrees Fahr.

Metallic Powder Used

After being cleaned, the parts may be coated with aluminum, bronze or gold lacquers. Metallic powders are used for this purpose, giving any desired finish. The powders are mixed with a suitable carrying liquid, either a good light coach varnish or a metal lacquer. The coach varnish is preferable for interior work. Before use it should be thinned with turpentine or benzine. For exterior work lacquer is more lasting, and will not crack or peel.

Aluminum, zinc and other alloys may be given a finish similar to gun metal by dipping in the following solution, after being cleaned:

Hydrochloric acid	12 per cent
Antimony choloride	1 to 2 per cent
Water	86 to 87 per cent

The parts should be immersed till well coated with a deep black powder, then thoroughly rinsed in clean water and dried, preferably with hot air. After this the black powder should be brushed or lightly buffed off. The parts should then be coated with coach varnish or transparent lacquer, as otherwise the finish will come off in time.

One of the chief reasons difficulty has sometimes been encountered in soldering zinc die castings is the formation of a fine coating of aluminum oxide on the die-casting surface. The heat conductivity of zinc is high, causing the solder to chill when applied and thereby preventing from alloying with the zinc. It is also necessary to heat the metal to 275 degrees Fahr., or slightly higher.

Any low-fusing solder may be used. A good solder of almost the same hardness and color of the zinc alloys is composed of:

Cadmium	50 per cent
Tin	30 per cent
Zinc	20 per cent

If cadmium is not desired the following may be used:

Zinc	15 per cent
Tin	84.875 per cent
Aluminum	0.125 per cent

A flux should be applied. A 20 per cent solution of zinc chloride, acidified with a few drops of muriatic acid, sufficient to keep the salt in solution. The acid, if not removed, will discolor and corrode the metal around the soldering joint. If this is objectionable, powdered rosin may be used as a flux, but it is a little more difficult to handle. The rosin may be manipulated easier if dissolved in alcohol.

The solder should be rubbed well into the casting before it chills to permit an alloy of the two to be formed. If possible the parts to be soldered should be rubbed against each other and heated sufficiently to keep the solder liquid while this is done.

The castings after being fluxed are sometimes dipped in molten solder which may be kept in a small pot over a low flame. Care should be taken not to overheat the solder, as this causes volatilization of the metals. If the solder becomes coated with a film of oxide, it should be cleaned with a pinch of sal-ammoniac. After the parts have been dipped they are assembled under the heat of a small torch.

Low-temperature solders should not be used for soldering aluminum as aluminum will not alloy with solders at low heats. Ordinary solders alloy with copper at about 450 degrees Fahr., which is increased to about 650 degrees in the case of aluminum.

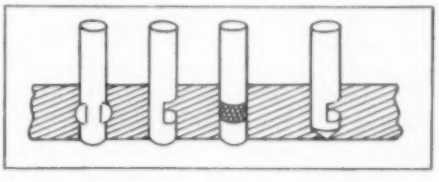
Difficulty is found in maintaining the proper soldering temperature in working aluminum because it is such an excellent conductor of heat and conveys the heat rapidly away, keeping the point to be soldered below the temperature needed to properly alloy the solder with the part.

It is frequently said that aluminum is difficult to solder because it has a *greasy* surface. Aluminum on being exposed to the air, instantly becomes coated with a fine invisible film of oxide which prevents the solder from coming in contact with the metal. In order to attain a good joint, it is therefore necessary to secure a clean surface by removing this coating.

When metals other than aluminum are to be soldered, it is easy to do this with fluxes or soldering salts, but no satisfactory chemical method of removing the oxide from the surface of aluminum has been found. Therefore no flux should be used except such cleaning fluids as may be needed to clean the surface of dirt and grease. This only applies to the tinning of the aluminum surface, but after it has been tinned the usual fluxes should be used.

Oxide Film Interferes

Aluminum should be soldered by heating it to about 650 degrees Fahr. and rubbing the solder into the surface of the metal with a stick of solder or with a blunt instrument or brass wire brush. In this manner the oxide film will be mixed into the solder and the solder permitted to come in direct contact with the part before any air can touch the aluminum surface. The solder must be rubbed in thoroughly and care taken that during the operation it remains perfectly liquid. After the surface is tinned, it may be soldered to other parts in the usual way. The best method of applying the heat is by blast



METHOD OF ANCHORING

lamp or blow pipe. A soldering iron is not entirely satisfactory. The durability of the joint will depend upon the care and thoroughness with which the solder is rubbed in.

The chief ingredients in aluminum solders are tin and zinc. Additions of small percentages of other metals to the tin-zinc alloy are frequently recommended

but their utility has not been demonstrated. Among them are cadmium, bismuth, lead, copper and nickel.

It is not practical to make solder flow into an aluminum joint. The solder must be put where it is wanted by tinning the parts first. After being prepared the parts are held together and heated sufficiently to make the solder fluid and then they may be chilled by plunging in water. Care must be taken to permit the joint to set and it should not be moved while the solder is fluid. A soldered aluminum joint will not hold under water or in moist air and all such joints should be painted, varnished or coated to protect them from corrosion.

When a polished surface is required on die castings buffing is essential. For very fine work the surface is first polished with about No. 150 emery, which must be applied with a mixture of paraffine and beef suet, prepared with carbolic acid. Dry emery will tear the surface and embed itself in the castings. The surface only should be touched and care should be taken not to go below the skin of the casting. The castings are then cut down with tripoli compound or similar material. After this, color with some suitable compound. In handling fine work, gloves dipped in whiting should be used. Long tubular pieces should be polished lengthwise, and not crosswise, to avoid a wavy surface. The castings should not be allowed to get so hot while being polished that they cannot be held in the hand, as it will cause them to crack and will injure the surface of the castings.

The surface must be cleaned from oxides and all foreign substances. Dirt and polishing materials are sometimes first removed with gasoline or benzine. The castings are then immersed in a hot cleaning solution at about 150 degrees Fahr. If necessary, the cleaner may contain about half a pound of caustic soda to the gallon, but should never be so hot or strong that it attacks the metal to any appreciable extent, and the dip should be for a few seconds only. There are several less harmful cleaning solutions on the market containing mild alkalis which may be secured from any well stocked plating supply house. A good cleaner is made of 1 pound of soda ash and ¼ ounce cyanide of potassium to 1 gallon of water.

Caustic cleaners react with the grease, usually present on all castings, forming a soap which goes into solution. They also react with the zinc-base alloys forming zinc oxide and hydrogen. If the casting is plated before all the caustic is cleaned off, gas will be generated after the plating is on and in attempting to escape will raise the layer of plating, forming blisters which eventually will cause the plate to peel. It is therefore advisable to wash off all salts by immersing in two changes of clean water of the same temperature as the cleaning bath.

Castings which have been corroded by contact with moisture or liquids may first be cleaned by dipping for a few seconds in a solution of four parts of water to one of hydrochloric acid, which will dissolve the oxide. This solution should of course be cold and the parts should immediately be washed in water of the same temperature before passing through other cleaning operations and brushed to color. This operation is not used when the castings are first polished, as surface corrosion would be removed sufficiently by that operation.

Another method of cleaning is with what is known as an electric cleaning bath. The solution usually contains alkalis. A formula well recommended is:

Caustic soda	½ pound
Carbonate of soda	½ pound
Sodium cyanide	½ pound
Water	1 pound

Next to magnesium and aluminum, zinc is the most electro-positive of the common metals. When metallic zinc is immersed in an acid solution containing metals electro-negative to it, those metals are reduced to their metallic state in the form of fine particles, usually black in color and sometimes in a spongy mass.

When zinc castings are immersed in a nickel bath, a reaction instantly occurs before the electric current acts, thereby some nickel is deposited on the casting by immersion in the form of a black finely divided nonadherent metallic powder. Such deposit when coated with gray nickel, as sometimes happens after a substantial black deposit, causes the plating to become loose and peel. Attempts to overcome this by introducing various salts intended to reduce the potential between the zinc and nickel have not proved satisfactory. Magnesium sulphate has been recommended for the purpose. The addition of sodium nitrate to the bath is sometimes recommended to retard the chemical deposition of the black powder on the zinc, which it does to a limited extent.

In all cases the deposition of nickel should be started with an electromotive force of about five or six volts, which later should be reduced to about 2½ to 3 volts. In doing this care must be taken that the initial voltage is not maintained long enough to burn the work. For direct nickel plating on zinc castings the following bath is recommended:

Single nickel sulphate	34 ounces
Nickel chloride	2 ounces
Boric acid	4 ounces
Sodium citrate	24 ounces
Water	1 gallon

For flat articles having no recess or hollows, the following bath will give satisfactory results:

Double nickel salt	6 ounces
Single nickel salt	3 ounces
Nickel chloride	2 ounces
Boric acid	1 ounce
Water	1 gallon

Potential at start should be 6 volts and gradually be reduced to about 3 volts. Keep the bath slightly acid with boric acid.

Brass is deposited in the same manner as copper, with the addition of zinc salts. The ratio of zinc to copper should not be in the proportions used in making alloys, but rather in the proportion of the chemical equivalents of the two metals, i.e., 63½ parts of copper and 32½ parts of zinc. The color may be deepened or made lighter by reducing or increasing the zinc content. The formula is:

Copper cyanide	4 ounces
Zinc cyanide	4 ounces
Water	1 gallon

Potash or soda in slight excess above that necessary to dissolve zinc and copper.

Anodes of rolled brass should be used with an anode surface always in excess of the area to be plated. Electromotive force required is 5 volts. Best results are secured when bath is kept at room temperature. There should always be sufficient free cyanide in the bath to keep the anodes clean and free from slime, for only a small excess is needed for this purpose and no more should be used than is necessary.

Another bath recommended is:

Sodium carbonate	4 ounces
Sodium bisulphate	3 ounces
Copper cyanide	2 ounces
Zinc cyanide	2 ounces

Potash or soda in quality sufficient to clean, and a slight excess.

Water	1 gallon

Castings are seldom copper plated for finish, but a copper coating usually is put on as a base for another deposit, to protect castings from corrosion. This may be done by a copper *strike*, or *starting* bath. A good formula is:

Copper cyanide	4 ounces
Water	1 gallon
Potash or soda...—enough to give good results	

Best results are obtained with cast anodes. They should be cleaned and scrubbed occasionally to remove the slime which materially weakens the conductivity of the bath. The bath should be kept at room temperature and the current held at 5 volts at the start and later reduced to 2½ or 3 volts. After the castings have been struck in copper, other finishes may be applied according to general plating practice.

Efficient Pattern Shop and Store System

(*Concluded from page* 403)

tion and ample ventilation. All tools are fitted with dust exhaust outlets to remove shavings and sawdust. The dust collecting system carries the waste materials to a tank outside the building located sufficiently high so that the contents may be dumped into a truck through a swinging chute, without shoveling. The distance from this shop to the power plant was too

great to make it advisable to exhaust at such long range.

Along the north bay nine benches are provided at right angles to the wall, and clear of the wall so that the workman may pass entirely around the bench. Each bench has a floor outlet from which electrical power is obtained for bench tools and for individual lights. On the wall for each pair of benches is an electrically heated glue pot. The opposite side of the room has space reserved for heavy pattern making on horses or skids. Outlets are provided on the wall in this department for glue pots and hand tools. Three compressed air outlets along the center line of the floor afford a supply of air for any purpose.

On this floor provision is made for installing large lathes and two pits are provided in the floor to allow for a six-foot and seven-foot swing in making patterns up to 12 or 14 feet in diameter. Lumber is brought from storage on the first floor by elevator, and tools are arranged so that work progresses regularly, passing first the swing saw, then the band saw and then to the benches. All machines have individual motors and automatic push buttons for starting and stopping.

Correcting Flaws in Metals and Mixes

Problems of the Gray-Iron, Malleable and Steel Foundry Discussed

By H. E. Diller

Difficult To De-Oxidize High Nickle Steel

Question—We have a few simple castings which should have minimum expansion. According to some information we have been able to get, the best alloy should contain around 0.50 per cent carbon and 0.50 per cent manganese, with silicon not under 0.20 per cent and nickel 37 per cent. We have made two melts which gave the following analysis:

	First	Second
Nickel	78.84	37.34
Carbon	0.13	0.64
Silicon	0.09	0.44
Manganese	0.52	0.58

In the first case we aimed at low carbon, but the castings came porous. The second heat we tried for a higher carbon and also a higher silicon. As in the first heat the alloy was wild and split badly although the amount of silicon which was in the alloy would usually quiet molten metal. These castings were also full of holes. We added the carbon in the form of gray cast iron and manganese as pure manganese. We have heard that carbon added in this form prevents the silicon from performing its function, that is, the carbon dioxide formed does not allow the silicon to combine with the oxygen to give a sound casting. Do you believe this is true? Is it better or in the form of scrap files. We used in our mix electrolytic nickel and low-carbon sheet steel. Would aluminum be better than manganese for a deoxidizer and what percentage would you recommend?

Answer—It is rather evident that your trouble is the same as is usually experienced in making alloys with nickel. That is—that once oxidized, it is difficult to de-oxidize. We would recommend that you melt the steel first and de-oxidize it, then add your nickel gradually, keeping the slag as neutral as possible. In this way the alloy will not become highly oxidized and you will have no trouble with porous castings. If the nickel is added at the start it will be necessary to maintain a neutral or deoxidizing atmosphere in the furnace throughout the heat.

Discussion Invited

Melters and engineers having had experience with melting high-nickel steel alloys in the electric furnace can no doubt add to the information in regard to the practice. Contributions from them will be gladly received.

Peening to Straighten Warped Castings

Question.—Some of the gray-iron castings for boiler fronts which we make do not come straight. Will you please let us know whether they could be straightened by peening, or is this not practical on castings with heavy sections?

Answer.—The best way out of your trouble would be to teach the molders how to uncover the castings immediately after they are cast so that they will always come straight. This can be learned with a little experience and after that the molder should be made responsible for securing straight castings.

However, warped castings can be straightened by peening. This is done on quite heavy sections, but is a difficult operation, and a great many blows are required to straighten the casting as it may not be struck too hard for fear of breaking it.

You could also straighten your casting by placing it on piers with the convex side up and putting a heat under the casting. The heat should be held until the casting has settled a little more than straight. It will then go back to the correct form when cooled. In heating such a casting, care must be taken to have the entire casting hot or it would be likely to crack. By heating the casting from the concave side this side is expanded more and the casting is thus allowed to straighten.

Excess Phosphorus Causes Holes in Castings

Question—We are manufacturers of a high grade white iron product, but have considerable trouble at times with the presence of blow holes. We have tried the effect of a good many ferroalloys without much success. Several analyses of our material show a presence of 0.05 per cent nitrogen. Would this percentage of nitrogen have any direct bearing on any blow holes found in our castings?

Answer—So far nothing has been definitely proved to show that the presence of 0.05 per cent nitrogen in iron would be detrimental. In fact, the whole problem of the gases in iron is somewhat in a haze. Some metallurgists claim that oxygen benefits iron while others claim it is detrimental. However, if the iron was too highly oxidized the gas would be apt to be forced from the metal as it sets and cause blow holes. This is probably the cause of your trouble.

Compressor Casting Leaks

Question—We are making a compressor which is used in refrigerating work. The gray-iron castings we get, frequently are too porous to hold the volatile liquids and we should like to know a

method of treatment which would completely close the pores.

Answer—Castings which are porous and leak under pressure are sometimes treated by allowing them to weather in the outside atmosphere for six months or longer. A more rapid process is to let them soak in a solution of salammoniac and then allow them to stand in the weather for a week or more. Still another process is to force a dilute solution of water glass into them. This fills the pores and when the water glass is taken out of the cylinder the solution in the pores dries and hardens. However, all of these methods are questionable and the best plan is to make castings which do not leak. To do this you should see that the design of your casting is correct and that as little change as possible is made in the thickness of the different sections, so that a thin section does not draw metal from a heavy section. The next point is to secure the proper metal. This should have a fairly low silicon, probably 1.5 to 2 per cent, depending upon the thickness of the section of the casting. The manganese should range from 0.6 to 0.9 per cent and the sulphur should not be over 0.12 per cent. Phosphorus should be kept low, about 0.2 per cent. This latter can be accomplished by using malleable pig iron.

Cupola Is Not Adapted for Small Melts

Question—We contemplate the manufacture of approximately two to three thousand pounds of high class gray-iron castings per week and it does not seem feasible to install a cupola for this small amount of work. Will you kindly advise us what kind of a furnace we should procure? The castings we propose to make vary from 1 to 30 pounds each in weight and the metal must be easy to machine. What proportion of scrap and what grade of pig iron should we use?

Answer—As you say, it would hardly be feasible to install a cupola for melting metal for 1 to 1½ tons of castings per week. The only two furnaces which would be possible would be the acid-lined electric furnace, or the Schwartz oil or gas-fired furnace. Either could be secured in small units, but the Schwartz furnace would have a lower first cost.

Iron for your castings, as far as we can tell by your description, should be made of a mixture of 5 to 10 per cent steel scrap, all the sprues and scrap castings which you make and the balance pig iron. The pig iron should be of such a composition that the finished castings will contain approximately 2.25 per cent silicon, 0.4 per cent phosphorus and 0.5 per cent manganese. The sulphur in either the electric or the Schwartz process with standard pig iron would be reasonably low.

In order to get castings from the foregoing analysis from the Schwartz furnace you would probably have to order pig iron with 3 per cent silicon. The amount of phosphorus would be the same in the pig iron as in the casting, but the manganese in the pig iron would have to be around 0.7 or 0.8 per cent. Silicon in pig iron for the electric furnace could be a little lower about 2.75 per cent.

Suitable Metal Mix for Mine Car Wheels

Question—Could you furnish us with a semisteel mixture for making mine-car wheels? We have 3 per cent silicon pig iron, stove plate scrap and all kinds of steel scrap.

Answer—You would have difficulty in making satisfactory chilled mine-car wheels from the stock of metal you have. Not more than 10 per cent steel should be used in the mixture. Scrap of unknown composition gives a variation in the mixture so that the chill would be greater in wheels poured from one part of the heat than from any other. The best thing to do would be to buy a low-silicon pig iron and use only your own cast-iron scrap from car-wheel metal, with 10 per cent steel scrap. Some of the manufacturers of chilled mine-car wheels use as high as 25 per cent charcoal pig iron. If you do not have close metallurgical control of the iron it is advisable to be conservative in the way you make up the mixture.

The mixture should be such as to give an iron with approximately 1 per cent silicon, less than 0.12 per cent sulphur, 0.20 to 0.40 per cent phosphorus and 0.50 to 0.80 per cent manganese. The proper amount of silicon will be governed by the section of the wheel tread and can be determined by the depth of chill obtained. The wheels should be placed in annealing pits as soon as possible after being poured to prevent the spokes from cracking.

Analysis Will Not Show Mixture Employed

Question—Is it possible to determine from a chemical analysis of a casting what grades of iron were in the mixture?

Answer—You can, of course, determine the composition of the iron from a chemical analysis and could make a mixture to duplicate the composition, but you could not determine what grade of pig iron or how much steel or cast-iron scrap was used in the mixture. A mixture of No. 1 and No. 3 pig could be used to give the same composition as though all No. 2 pig iron was used, or No. 3 pig iron could be used with ferrosilicon, etc. Gray-iron scrap could be used of approximately the same analysis as pig iron except for a little higher sulphur content which might be made up in a pig-iron mixture by absorbing an undue amount of sulphur from a high-sulphur coke.

The main difference which steel makes in the composition is to lower the percentage of phosphorus, but you could not determine how much this element was lowered without knowing how much phosphorus was in the pig iron. Steel also affects the amount of total carbon in the metal, to a slight extent, but as the iron coming through the cupola picks up carbon from the coke in varying amounts according to the temperature, it would be impossible to determine how much steel is in the mixture by determining the total carbon. In fact, 10 per cent of steel in the mixture, as a usual thing, would not show any results in the total carbon in the iron.

Exhaust System Removes Cleaning Room Dust

In a paper on cleaning and grinding castings, read before the Manchester Association of Engineers, Manchester, England, F. W. Wilson urged the need for protecting the workers from the effects of the dust which comes chiefly from the sand cores.

For this purpose he proposed, in suggesting a lay-out for a cleaning room for iron castings up to 20 tons, the provision of pits covered with perforated steel floor plates on which the castings would be placed during coring. By means of hoppers connected to an exhaust fan all the sand and dust would be drawn downward away from the worker. Canvas sheets round the pits would improve the down draft. The sand would be drawn to a closed chamber and the light dust drawn through the exhauster and deposited in a water tank. A perforated floor measuring 9 x 12 feet, would require an exhauster capable of dealing with 2500 cubic feet of air a minute. This would draw the dust down from a height of about six feet and transport about 1 cubic foot of sand a minute. The sand off the castings would thus be taken away automatically, and the saving of labor in wheeling it away must be set against the cost of operation. When the work is carried out on benches, these might similarly have perforated tops, connected with the exhauster.

Research To Aid Foundry Industry

The Field of Research in Connection With Problems Connected With Foundry Practice Is Practically Unlimited and Barely Has Been Scratched Up to the Present

BY J. H. ANDREWS, B.SC.

THE application of the microscope to the solution of iron foundry problems is now well recognized. However, unfortunately the common impression prevails among foundrymen that the data secured through microscopic methods represents the last word in scientific research. This is accounted for by the fact that the scientist whose business is to give us new methods, has been extremely backward in devoting his energies to foundry practice, partly from lack of encouragement and partly on account of the complex problems involved.

The microscope has its limitations. For instance, it does not enable us to distinguish silico ferrite or manganese ferrite from pure ferrite, nor silico carbide from pure iron carbide. Another factor which retards progress in this respect is that examinations are restricted to cold metal. Up to the present it has been impossible to follow under the microscope the changes that occur during heating and cooling. One can only observe the ultimate result. What really is required is not so much the evolution of new methods, as the application of those already in existence; methods such as now are largely employed in connection with steel research work. As examples of these methods, consider the value of thermal dilatation; electrical resistivity and magnetic determinations.

Thermal Determinations

If we take a number of cast irons, of various compositions, so arranged that we have several complete series in which but one element alone varies at a time, and take series of freezing curves at different rates of cooling (of each composition), we can arrive at a fairly complete understanding of the effect of the different elements upon the constitution. If, for instance, a series with varying silicon has been taken, it will be found that when the silicon content has reached a certain value, a curve similar to the freezing curve of a pure iron results. This would indicate that silicon, by precipitating the graphite from solution, has entirely eliminated it from the sphere of action. Moreover, by adopting standard rates of cooling, the very magnitude of the critical points would provide data of considerable value. Thus, by means of half a dozen or so curves taken in this way in the laboratory, all the results produced by numerous practical experiments, involving great cost, could readily be arrived at.

The fact that dilatation curves, or curves showing the expansion and contraction on heating and cooling, have proved themselves of great value in steel research is alone sufficient recommendation for their trial on cast iron problems.

Electrical Resistivity Determinations

Low temperature changes, which are rarely shown up on thermal curves, in most cases give rise to a marked kink in the dilatation curve; indeed, in steel-works laboratory experiments I found this to be, perhaps the most useful of all for physical measurements. The actual results and value of such determinations can, of course, only be arrived at by actual experiment, but one problem in particular presents itself above others with reference to the growth of cast iron. By observing the expansion and contraction during heating and cooling at different rates, and changes in volume occurring during soaking, it should be possible to arrive at a complete explanation of this phenomenon. True, much work has been done on these lines, but much still remains.

Any marked changes in constitution occurring during heating or cooling are clearly shown by a temperature-resistivity curve. For instance, the deposition of graphite or temper carbon would produce a marked increase in the electrical resistance. Would not this, then be an excellent method to use in the case of malleablizing practice? It would indicate the temperature at which carbon deposition begins, and also the temperature of maximum rate of deposition.

In microstructures of cast iron, the graphite in certain places appears to have crystallised out in the form of parallel plates running in the same direction. If it were possible to produce this directional separation at will, in order to produce a casting of greater strength along one particular direction, it would be found that the electrical resistivity was greater in the direction across these plates than along them. Resistivity measurements, then, provide an excellent method of testing for the regular distribution of graphite. Any heterogeneity would be disclosed by this test, which is often used for the detection of unsoundness in steel ingots.

Magnetic determinations are now employed in America to a slight extent for the detection of flaws in steel bars—measurements being taken along their length.

The blast furnaceman is guided to a considerable extent in the working of his furnace by the character of the slag. A great deal of scientific work recently has been carried out in America upon this subject, and all experiments have gone to show that the constitution, and in particular the viscosity, of the slag is of paramount importance.

I once was consulted with regard to iron castings which were coming out badly blown; the blowholes were all bright and did not show up until after machining, and the metal in the ladle had the appearance of being particularly gassy. I investigated the cupola practice, and was told that the only alteration that had been made on past practice was in the use of additional lime. My report on the matter was to the following effect: Silica has a strong affinity for FeO, but a stronger affinity for lime; therefore, when excess lime was added the silica was insufficient to combine with all the oxide of iron in the metal, with the result that the included oxide, by combining with the carbon of the metal with the formation of CO, gave rise to blown castings. Less limestone was then added, and all went well.

Cupola Slags

This illustration is given merely for the purpose of showing the importance of correct slag conditions, and how necessary it is to know more about this question.

One expects to hear the comment that the line of work suggested is of an altogether theoretical nature, and can lead to but little advancement in

From a paper read before the Institution of British Foundrymen at the annual conference held in Glasgow recently. The author, J. H. Andrews, is professor of metallurgy at the Royal Technical College, Glasgow.

practice. Perhaps the best way to disperse that idea is to mention that during my term of office in a steelworks research laboratory I gradually worked things to such a pitch that, wherever it was possible, before any new steel was placed on the market, a complete series of determinations such as have been mentioned, along with mechanical tests, Brinell-hardness determinations, and practical heat-treatment tests based upon the results obtained, were always carried out. Moreover this invariably was done at the request of the practical man in the works, who in the end came to rely upon their results for his practical treatment.

In conclusion I should like to say a few words upon research work in general. My advice to anyone contemplating carrying out research work—in particular, those who think of starting a works laboratory—is, "Do the thing thoroughly." Given adequate equipment and a highly-trained staff, your laboratory will more than pay for itself in a few years; but remember that research work takes time. Do not expect results too soon. On the other hand, half equip your laboratory, place it in the hands of a semitrained man, and you soon will prove to your own satisfaction that research work is a waste of money. No doubt much can be obtained from little material, but if you are out for the bigger things you must do the thing properly.

Tells How Abraham Darby Made Iron Pots

BY J. H. TAYLOR

AN ARTICLE by Pat Dwyer in the April 1 issue of THE FOUNDRY touching lightly on the part played by Abraham Darby of England in introducing the art of casting hollow ware in flasks interested me particularly inasmuch as the locality is one with which I have cause to be familiar. I was born in the town in which Darby carried on his experiments and as a boy worked in the old plant. Some of the shops of those days have been torn down since that time and others have been rebuilt and brought up to date in every respect. It has occurred to me that a slightly more extended history of the famous old iron master and his methods might prove of interest to foundrymen in general.

Abraham Darby, the first of a succession of iron manufacturers bearing the same name was the son of a farmer who lived at Wrensnest near Dudley. He served an apprenticeship to a maker of malt kilns near Birmingham and shortly afterward moved to Bristol to set up in business on his own account. He was a member of the sect known as Quakers and at Bristol was joined by three partners of the same persuasion who supplied the necessary capital to set up works at Baptist Mills, a place near Bristol where for some time he carried on the business afterward adding brass and iron founding.

At that period cast-iron pots were in general use, especially as cooking utensils among the working class. Owing to the backward condition of foundry practice in England at that time the pots were imported from continental Europe. The lucrative character of the business appealed to Darby, although in all fairness it is quite probable that his professional pride was aroused. Whatever the reason he instituted a series of experiments which resulted in failures for a considerable period. Like others who had preceded him he made his molds from clay, but they cracked and burst. To master the secret of the trade he determined upon a journey to the places where the best of these articles were manufactured.

Learns the Secret in Holland

In the year 1706 he went to Holland and discovered that the finest grade of hollow ware, known at that time as *Hilton ware*, was made in dry-sand molds composed of fine sand. Accompanied by several skilled Dutch workmen Darby returned to Bristol and succeeded in making pots after the continental manner. Lest other makers should take advantage of the process the work was prosecuted in the greatest secrecy. Precautions were taken to such an extent that even the keyhole in the work room door was plugged while the work was going on.

To secure legal protection he proceeded in the year 1708 to take out a patent on the process which was granted him for a period of 14 years. The text of the document following is interesting as showing the condition of the foundry industry in England at that time.

"Whereas our trusty and well beloved Abraham Darby, of Our City of Bristol, Smith, hath by his petition humbly represented to us that by his study, industry and expense, he hath found out and brought to perfection a new way of casting iron bellied pots and other iron bellied ware in sand only without loam or clay, by which such iron pots and iron ware may be cast fine and with more ease and expedition and may be afforded cheaper than they can be by the way commonly used and in regard to their cheapness may be of great advantage to the poor of this Our Kingdom, who for the most part use such ware, and in all probability will prevent the merchants of England going to foreign markets for such ware from whence great quantities are imported and likewise may in time supply other markets with that manufacture of Our Dominions: Grants the said Abraham Darby the full power and sole privilege to make and sell such pots and ware for and during the term of fourteen years thence ensuing."

Darby was anxious to carry on the manufacture on a large scale at the Baptist Mills, but his partners were reluctant to invest any more capital so the partnership was dissolved and Darby removed to Coalbrookdale with the intention of prosecuting the enterprise on his own account. He took the lease of a small furnace which had been in existence at that place for more than a century as is evidenced by records which show that a "Smethe" or "Smethe House" was there in the time of the Tudors.

The woods of oak and hazel which spread in an almost continuous forest to the base of the Wreken furnished abundant fuel for the smithery, but were gradually cleared as the trade of the Coalbrookdale firm extended. Finally the scarcity of fuel brought the manufacture of iron to a standstill.

According to a memorandum kept by Darby the amount of direct metal used for the manufacture of hollow ware at the Coalbrookdale furnace in the year 1713 varied from 5 to 10 tons a week. The remainder of the metal was run into pigs. In course of time other castings including smoothing irons, door frames, sash weights, baking plates, cart bushes and iron pestles and mortars were turned out. At one time as many as 150 pots and kettles were cast in one week.

At first charcoal was used exclusively for fuel, but the growing scarcity of wood seems to have led to the gradual use of coke, coke breeze and peat. Coal

was plentiful in the neighborhood and by selecting a superior quality and coking it with great care a substance was obtained superior to charcoal for fusing the particular kind of ore found in that locality.

Darby's favorite charge for his furnace consisted of five baskets of coke, two baskets of coke breeze and one basket of peat, this was followed by the ore and then by the limestone.

The castings made at Coalbrookdale gradually acquired an enviable reputation and the trade of Abraham Darby gradually increased up to the time of his death which occurred at Madeley Court in 1717. His sons were too young at the time to carry on the business which he had so successfully built up and several parts of the works were sold at a sacrifice to alien and outside interests.

After the sons had grown to manhood they entered the business of iron founding and their sons in turn succeeded them and largely extended the operations of the firm. As a result Coalbrookdale, or as it was formerly called, Bedlam, became the principal seat of one of the most important branches of the iron trade.

Air Hammer Used to Pulverize Sample

BY H. E. DILLER

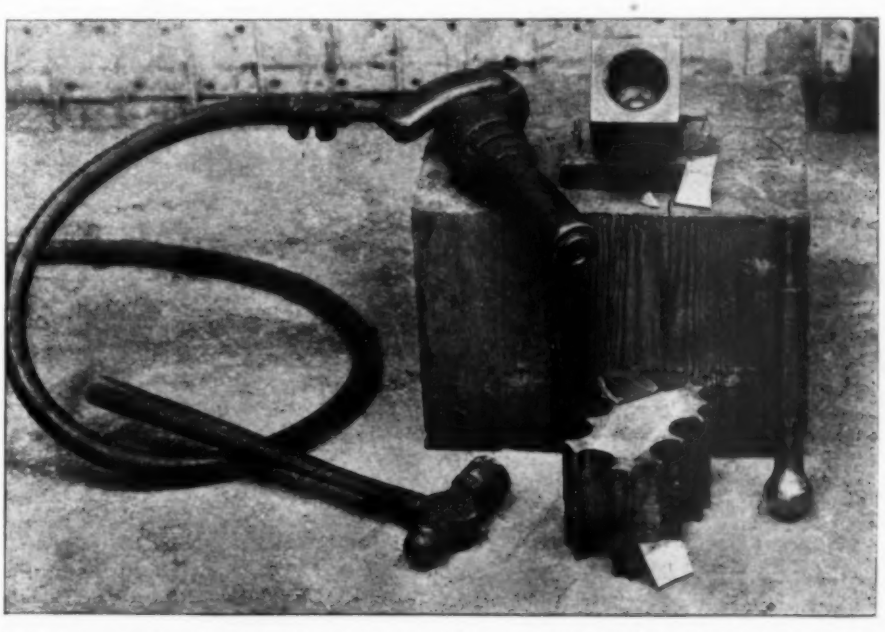
IN A malleable-iron foundry where a morning heat is succeeded by an afternoon heat from the same furnace the question of securing results of a chemical analysis of the heats as quickly as possible after they are poured is a big problem. One of the main difficulties is to prepare a sample for analysis quickly. If a sample is taken and cooled quickly, it is difficult to drill and the drill usually must be sharpened after each sample is drilled. Some chemists have a sample poured into a bucket of water slowly so that it takes the form of shot which later are broken in a diamond mortar with a machinist's hammer until the required fineness is attained. Others cast a thin strip of metal and after cleaning the sand from it on a grinding wheel break off small particles which are then ground finer in a mortar using a regular hand-operated hammer.

F. L. Hiller, chief chemist, the York Mfg. Co., York, Pa., has devised the equipment shown in the accompanying illustration, to pulverize the samples. A mold is made and a piece 2 x 4 x ¼ inch thick is cast in it. The piece is taken from the mold as soon as it sets and is cooled. After the sand is completely ground off the surface, small pieces are broken off by placing the sample on a block of steel and cutting with a chisel struck by a hammer. The irregular block used as an anvil may be seen near the hammer in the illustration. Pieces of suitable size then are placed in a tool-steel mortar such as may be secured from any chemical supply house. The pestle has been fitted to an air hammer and the sample is soon brought to the desired fineness.

To secure a 15 to 20 gram sample requires 5 to 10 minutes and much less manual labor than if the sample is pulverized with a hand hammer. All is reduced to pass a 100-mesh sieve. It has been found that the operation is assisted if an excess of sample is not put into the mortar at a time and the hammer is not pressed too hard on the sample. When the hammer is pressed too hard opportunity is not given for the pestle to strike a hard blow but the result is more in the form of increased pressure each time the air enters the cylinder. The method has proved satisfactory in reducing time and labor required to prepare the sample for analysis. Previously the custom had been to add a small amount of aluminum to the ladle of iron from which the sample was to be poured. This caused carbon to separate out in the free state and made the iron easy to drill.

While this method is entirely satisfactory for furnishing quickly a sample for analysis, little can be told about the iron from the fracture of the sample. A method for determining the state of the iron from the fracture, as practiced by some foundries, is to cast blocks of metal 3 inches square by 6 inches long with nicks approximately ¼-inch deep cast across the block half way between the ends on opposite sides. After the block has cooled below a red heat it can be taken from the sand, cooled in water and broken with a sledge hammer. The fracture will be quite dark if the silicon or manganese is too high and it may be any where from a gray to a pure white. This range is wide enough to give the operator a general estimate as to the state of the graphite-forming elements in the metal. A little experience soon will tell the amount of mottled appearance which should be in the sample to give the best results for the class of castings desired.

The amount of carbon in the metal may be estimated by the size of the shrink which appears in the center of the fractured surface. This is quite marked and the melter soon learns to determine the approximate amount of carbon in the iron from the shrinkage shown on the fractured surface of the sample. When an excessive amount of carbon has been burned from the metal or it is highly oxidized, gas holes are formed in the sample and appear on the surface when the sample is broken.



COMPLETE EQUIPMENT FOR PULVERIZING A HARD IRON SAMPLE WITH AN AIR HAMMER—NOTE PORTIONS OF THE SAMPLE LYING NEAR THE MORTAR ON THE ANVIL BLOCK

THE FOUNDRY

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Overhead Charge A Debatable Problem

OVERHEAD can be determined accurately for certain conditions but the calculations are easily upset when unusual circumstances arise. Consider for example molding equipment on which it has been figured that an overhead of $15 a day should be charged. When this equipment is not operated a loss is sustained equal to the amount which should be charged as overhead. Now if an opportunity is given to bid on a job which must be figured extremely close will it be considered the better plan to estimate a lower overhead and although working at a loss have the loss less than it would be if the equipment were lying idle? Some foundries do this and in fact they must do it to compete with the man with the low overhead. The case may be illustrated by the manufacturer producing castings with a squeezer and a plate who has a low overhead on molding and is able to compete with the foundry more elaborately equipped, because the overhead for the equipment in the second case is higher than when the plate pattern with the squeezer is used. However, when in need of work if the overhead on the equipment is not charged against the job the manufacturer who by more elaborate equipment can produce 500 or 600 molds a day with one molder can far underbid the shop which has little equipment and makes 250 molds a day with one molder. Then in dull times the small foundry must be closed if the shop with the elaborate equipment is operated without profit to keep the organization together unless, the orders even at the lower charge are too small to keep the equipment operating, when the smaller plant can obtain a share of the work. So it can be seen that the production of castings is not the most complicated phase of the foundry industry but the manager who does not get a true view of the economic side will not be able to compete successfully in the industrial race.

Plugging the Leaks in Profits

INDUSTRIAL inactivity arrived so suddenly and has continued so steadily that a wrong perspective has been given to a great number of manufacturers. Many are inclined to accept the winter of 1918 and 1919 as a forecast of what may be expected within the next few months. They expect a resumption of intensified production, patterned after the period which succeeded the post armistice depression. Accordingly, some foundrymen have taken no steps to alter the scheme of plant operation which was found satisfactory during the time when demand so far exceeded supply in castings manufacture. They expect another wave of prosperity, and do not realize that competition has returned beyond a question of doubt. When orders again appear, those who have not taken stock of every conceivable economy will be unable to face this competition. They fail to realize that no better time than the present could be offered for effecting economies. Equipment should be overhauled, wasteful practices ferreted out and eliminated, molding and melting practice scanned still further to reduce casting losses and new rigging devised wherever savings may be effected. Money saved through failure to provide efficient equipment, in the period to come, will be spent many times over in labor and material wasted. Economy may best be shown through stopping the many small leaks and by perfecting foundry processes.

Trade Outlook in the Foundry Industry

SIGNS of returning confidence are discernible following the first few days of May. Freight movement has improved. A lowering in the rediscount rate of the Federal Reserve system and a probable reduction in the interest figure on commercial paper promise much for the revival of business. At the same time a unified pressure is being exerted to bring about lower freight rates, the present tariffs constituting in the minds of many the one great obstacle to industrial activity.

More Freight Moving

Probably the most accurate barometer of business conditions is furnished by the record of idle freight cars throughout the country. During the week of April 15, this figure showed a decrease for the first time in many weeks. The period mentioned showed 7498 less inactive freight cars than the previous week, due probably to the increased demand for coal cars. The previous week constituted the record, showing over 500,000 idle cars. While the betterment is not marked, taken with the other features which are evident, improvement is presaged. Railroads still are not active factors in the castings market. Foundries which handle railroad work are practically idle, except for a few which have some repair orders which enable them to operate part time. During the month of April, orders for cars decreased. Only 425 cars were placed during that month, while during March, which usually is not an exceptionally busy month, over 2400 cars were ordered. However, inquiries showed a marked increase for April and in the face of brightening prospects, May probably will excel the previous month in the volume of business coming from the railroads.

Prices of Raw Materials for Foundry Use

CORRECTED TO MAY 5

Iron		Scrap	
No. 2 Foundry, Valley	$23.75 to 25.00	Heavy melting steel, Valley	$12.00 to 12.50
No. 2 Southern, Birmingham	23.00 to 25.00	Heavy melting steel, Pitts.	13.00 to 13.50
No. 2 Foundry, Chicago	23.00 to 24.00	Heavy melting steel, Chicago	11.50 to 12.00
No. 2 Foundry, Philadelphia	25.75 to 26.85	Stove plate, Chicago	15.00 to 15.50
No. 2 Foundry, Buffalo	25.00 to 26.00	No. 1 cast, Chicago	15.75 to 16.25
Basic, Valley	22.00 to 22.50	No. 1 cast, Philadelphia	18.00 to 19.00
Basic, Buffalo	25.00 to 26.00	No. 1 cast, Birmingham	15.00 to 16.00
Malleable, Chicago	23.50 to 24.50	No. 1 cast, Buffalo	18.00 to 18.25
Malleable, Buffalo	25.50 to 26.00	Car wheels, iron, Pittsburgh	15.00 to 15.50
Coke		Car wheels, iron, Chicago	14.50 to 15.00
Connellsville foundry coke	$ 4.50 to 5.25	Railroad malleable, Chicago	13.50 to 14.00
Wise county foundry coke	6.50 to 8.00	Agricultural mal., Chicago	13.50 to 14.00
		Railroad malleable, Buffalo	11.50 to 12.50

Auto Plants Active

Automobile demand continues to be the mainstay of the foundries of the central and north-central states, and even this support is but feeble as compared to what it was a year ago. The National Automobile chamber of commerce states that a survey in all sections shows that sales of finished machines are rapidly approaching 75 per cent of the 1920 level. However, this is not directly reflected in the activity of automotive foundries, as the stocks of castings both in the hands of the manufacturers and in the foundry yards are little diminished. March sales in the New York territory compiled from a summary of all companies, were six times as great as those shown for January of this year. In January 571 cars were sold, in February 1568 and in March 3304. Truck and tractor concerns up to the present have not shared the seasonal prosperity of the passenger car manufacturers, although a few exceptions are noted. Price reductions are presaged by the action of one or two manufacturers of medium priced automobiles. Manufacturers of machine tools still are pessimistic and foundries catering to this class of equipment are practically idle. Heavy cranes and handling machinery also are quiet. A tendency of the times is noted by the effort of some makers of equipment to exchange finished machines for raw materials, thus returning to a barter basis of trade. One foundry is said to have been offered finished automobiles at a liberal discount, in return for castings already delivered and others yet to be made. Molding machines and handling machinery have figured in similar transactions which indicate credit tightness.

Implements Hard Hit

Conditions in the agricultural implement and farm machinery foundries are unimproved. During the past two weeks several large implement companies in the central west have closed their plants indefinitely. It is stated that price cuts which were made in the various farm machinery lines brought the sales price below the cost of production. Little expectation exists for new business before the fall harvests. With the exception of the plants serving the industry just mentioned, the malleable shops report a slight increase in demand for castings. The pickup in automobile lines, aided by activity in electrical machinery has assisted this tendency. Pig iron production, according to figures compiled by *The Iron Trade Review* fell to a new low level in April. The figure for the month is lowest reported in 13 years, or since June, 1908. April was the sixth month which has shown a decrease over the previous period. The total given is 1,192,071 tons, a loss of 402,785 tons as compared with the March total of 1,594,866 tons. A slackening in the steep descent is apparent from the decrease in the total number of stacks which were blown out during the month. April shows a loss of only seven stacks, while the lowest net loss in the previous months during the slump was 23 stacks. The April output of the merchant furnaces was 211,366 tons, which compared with the previous month's total of 276,599 tons gives a loss of 65,193 tons. The daily average merchant pig iron output was 7045 tons for April, a loss of 1876 tons as compared with the March average. This shows a decrease of 21 per cent in the daily tonnage.

Nonferrous Prices

New York prices for nonferrous metals based on *Daily Metal Trade* for May 5 follow: Casting copper, 11.62½c to 11.75c; Lake copper, 12.75c to 13.00c; lead, 4.50c; antimoney, 5.25c to 5.37½c; aluminum, No. 12 alloy, producers' price, 27.30c and open market, 18.50c to 20.50c. Zinc is 4.95c, E. St. Louis.

Comings and Goings of Foundrymen

CHARLES LEONARD NEWCOMB, manager of the Deane works of the Worthington Pump & Machinery Corp., Holyoke, Mass., on April 21 completed forty years of active service with that institution. The occasion was marked by a noon hour meeting and reception, staged by the employes, when Mr. Newcomb was presented with a silver testimonial tablet in recognition of his activity and in testimony of the esteem in which he is held. The presentation was made by Harry M. Chase, engineer and a member of the Deane organization since 1891. Mr. Newcomb is widely known throughout the foundry industry. He has been actively associated with the National Founders association since its inception, and also has been active and held offices in the National Metal Trades association. He recently served as president of the New England Foundrymen's association, and has been an active member in the American Society of Mechanical Engineers since 1883. In 1919 he took an active part in the formation of the Engineering Society of Western Massachusetts, of which organization he was the first president. All of these technical and business bodies were represented and felicitated Mr. Newcomb on the fortieth anniversary of his connection with the Deane works.

Paul Ramp has been appointed foundry superintendent of the American Steam Pump Co., Battle Creek, Mich.

John L. Abbott succeeds H. L. Duerner, retired, as general superintendent, Union Steam Pump Co., Battle Creek, Mich.

Henry Knauber has retired from the partnership conducted under the name of the Advance Pattern Co., 7-9 West Canal street, Pittsburgh. The business will be carried on under the same name by P. E. Fisher and Clarence O. Fisher.

John A. Baker, formerly assistant general superintendent of the Mesta Machine Co., Pittsburgh, has been appointed works manager for the Los Angeles plant of the Rich Steel Products Co., Los Angeles and Battle Creek, Mich.

John O'Donnell, for many years with the McCormick works of the International Harvester Co., Chicago, later with American Brake Shoe & Foundry Co., Minneapolis plant, has been appointed foundry superintendent of Michols & Sheppard Co., Battle Creek, Mich. This plant is operating on threshing machinery.

W. D. Creque, formerly general superintendent Advance-Rumley Co., Battle Creek, Mich., has been made works manager of the Johnson Automatic Sealer Co., which concern operates a small light gray iron foundry department in Battle Creek.

Frank J. Lanahan, president of the Fort Pitt Malleable Iron Co., Pittsburgh, was elected to the board of trustees of Carnegie Institute of Technology and of Carnegie Library to succeed the late Congressman Henry Kirke Porter at a meeting of the board held April 25.

CHARLES LEONARD NEWCOMB

Walter Q. Zahrt, assistant general manager of S. F. Bowser & Co., Fort Wayne, Ind., pump manufacturers, and Alvin V. Burch, president of the Blount Plow Works, Evansvlile, Ind., have been appointed members of the Indiana state highway commission by Governor McCray.

Dr. Albert Sauver, professor of metallurgy at Harvard university, has been elected an honorary member of the American Society for Steel Treating. The certificate of membership was presented him by W. H. Eisenman, secretary of the society, at a meeting of the Cleveland chapter.

Acheson Smith, president of the Acheson Graphite Co., Niagara Falls, N. Y., and president of the Electric Steel Furnace association, which was organized in 1919, has been elected president of the American Electrochemical society which has absorbed the Electric Steel Furnace association. Mr. Smith succeeds Walter S. Landis as president of the Electrochemical society.

Charles A. Moffett, has been made president and general manager of the Gulf States Steel Co., succeeding James Bowron who was made chairman of the board. Charles A. Moffett who has had a varied experience including long service in the foundry industry was born at Tallassee, Ala., on April 4, 1864. At the age of 16 he went to work for Noble Brothers, taking up the foundry and machine shop trades. Later he went with the Brierfield Coal & Iron Co. as foreman, at the Brierfield works in 1885. He removed to Birmingham in 1886 and became foreman for the Williamson Iron Co,, at that time operating a small blast furnace and an iron foundry. He next was with the Birmingham Machine & Foundry Co. as foreman and there received a promotion to the position of draftsman and designing engineer. He started a foundry known as Moffett and Bonholzer in 1901, but operated it only for 18 months, when he sold the plant and went with the Republic Iron & Steel Co. at the Thomas plant as chief engineer. In 1908 he went with the Birmingham Coal & Iron Co. as superintendent of machinery, giving most attention to mining. In a reorganization of the Southern Iron & Steel Co. he was made chief engineer on August 1, 1909 and held the position in charge of the steel plant at Gadsden as works manager and was promoted to the position of vice-president and general manager when the Gulf States Steel Co. was organized in 1913.

Study German Conditions

Dr. Richard Moldenke, Watchung, N. J., mentioned in a disptach from Berlin as one of the three Americans chosen to act as mediator between Germany and the Allies, has been in Germany for a month. He went abroad with a group of American bankers on an industrial mission which it was intimated was to negotiate a credit loan so that Germany's industrial plants could get back to normal conditions. Dr. Moldenke for-

merly was secretary of the American Foundrymen's association and was actively connected with a number of other scientific organizations. President Roosevelt, during his administration, appointed him on a commission to investigate mining conditions in this country and recommend safety devices to afford greater protection to miners.

Will Head New Company

George W. Kyle has resigned as president and general manager of the General Platers Supply Co., Inc., 489 Broome street, New York City, to become the exclusive distributor of that company's merchandise and products. H. L. Haas also has resigned as secretary, to become affiliated with Mr. Kyle. This business will be incorporated as George W. Kyle & Co., with offices and warehouse at Grand and Thompson streets, New York city.

Complete New Plant for Making Sea Coal

The Federal Foundry Supply Co., Cleveland, recently has completed its seacoal facing plant at Charleroi, Pa. This plant is built immediately adjoining a coal mine which produces a high grade gas coal of the following analysis:

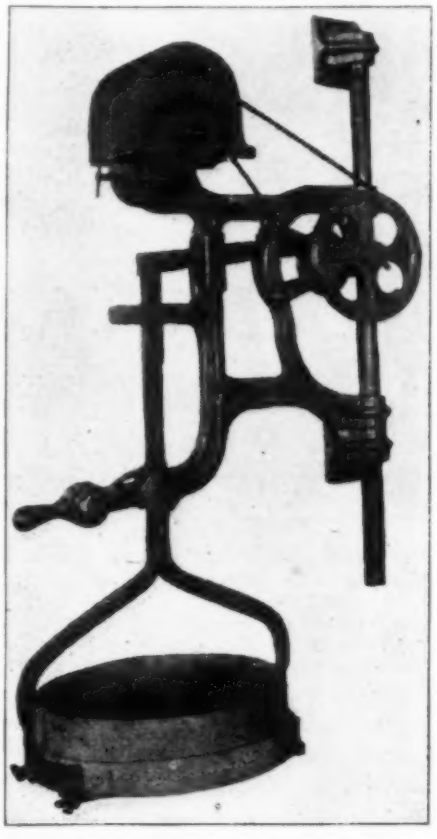
Moisture	.95
Volatile	36.05
Fixed carbon	56.70
Sulphur	.75
Ash	4.55

This coal is delivered directly from the mines into the bins of the Federal company by mine cars. It can be delivered at the rate of 200 tons per hour. Shipping facilities are provided over the Pennsylvania railroad, which has a siding upon which the company may load eight cars at a time. The plant has a capacity of eight to ten tons of finished coal per hour and may be operated in case of need 24 hours per day.

Motor Driven Riddle Is Easily Adjusted

The riddling device shown in the accompanying illustration and made by the Chicago Molding Machine Company, 2028 North Major Avenue, Chicago, has been designed to withstand the severe service to which foundry equipment usually is subjected. The frame is a one-piece casting insuring rigidity as well as freedom from troubles incident to vibration. In fact it is claimed that putting a few drops of oil in the motor bearings occasionally is the only attention required to keep this device in continuous operation.

It can be mounted in the core room for mixing core sand or attached to any of the columns in the foundry for mixing facing sand for the molders. It may be arranged over a tub in a brass foundry or fastened to a brick wall, post or partition for the use of the stationary bench molders. It also may be bolted to any one of the several types



THE FRAME SWINGS ON A SHAFT SUPPORTED BY TWO BEARINGS WHICH CAN BE ATTACHED TO A SUITABLE SUPPORT ANY PLACE

of molding machines using railroad rails or I-beams.

The motor which is totally inclosed and protected from the dust is connected by a belt to a small wheel mounted on a shaft with an eccentric. The motion of the eccentric is transmitted through a horizontal bar to the fork supporting the riddle and the resulting movement of the riddle corresponds closely to the motion attained in hand riddling. The grips for holding the riddle are provided with two long rods extending from side to side under the riddle, threaded at one end and carrying wing nuts by which the riddle may be made fast or loosened.

Addresses Foundrymen of Twin Cities Club

Frank D Chase, Frank D. Chase, Inc., Chicago, addressed the Twin Cities Foundrymen's club, Minneapolis, April 27, on "Location, Layout and Design of Foundries." He will address students of the College of Engineering, University of Illinois, at Champaign, the first week in May on "Factories and Foundries; Their Location, Layout and Design." Mr. Chase recently spoke before the Association of Commere, Winona, Minn., the Manufacturers' Bureau of the Chamber of Commerce, Des Moines, Iowa, the Kiwanis club, Cedar Rapids, Iowa and students of Purdue university, Lafayette, Ind.

Will Discuss Handling at Engineers Meeting

The new materials handling division of the American Society of Mechanical Engineers is planning sessions for the discussion of "Design and Construction of Machinery for Road Building" at the Society's Spring meeting to be held at the Congress Hotel, Chicago, May 23-26.

The work of this division, the membership of which rapidly is approaching 1000, is now well under way. The executive committee is composed of R. M. Gates, chairman, Philadelphia; H. V. Coes, vice-chairman, New York; N. C. Johnson, New York; F. A. Wardenberg, Wilmington, Del.; and Kern Dodge, Philadelphia.

Welding Vertical Cracks in Cast Iron

Autogenous Welding, published by the Davis-Bournonville Co., Jersey City, N. J., recently discussed welding gray iron castings which must be left in place. A case in point is a locomotive cylinder which can be preheated as it is without difficulty In such cases the welder must often operate on seams running vertically or sometimes overhead. While it may be possible for an expert operator to weld cast iron vertically or even overhead without mechanical aids it is undesirable to do welding in this manner.

The use of carbon blocks is generally advocated for vertical cast iron work, especially when building up shapes like gear teeth. Another expedient which in some cases has advantages over carbon blocks is strap iron "clamps" bent to an approximate half circle, having "ears" projecting each side similar to the forms sometimes used for pipe hangers or supports. These made of wrought iron or low carbon steel say 1 inch wide and ⅛ inch thick and having a radius suitable for the weight of the weld, may be used on vertical and overhead welding to advantage as follows:

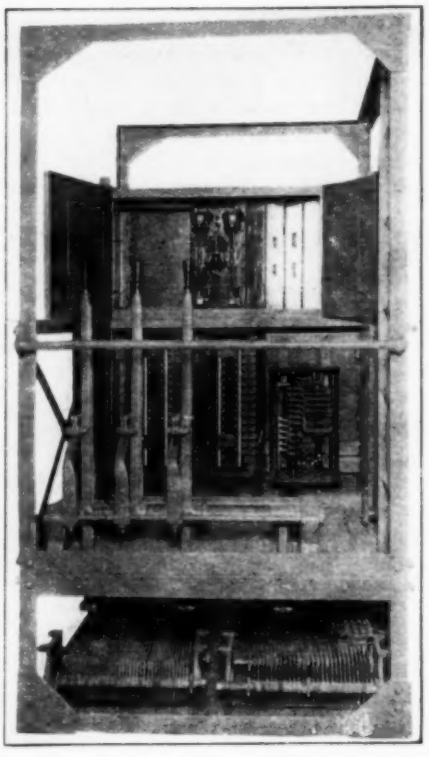
One of the clamps is tacked over the

crack, bridging the seam and fastening the ears to the parent metal on each side. The weld is puddled and built into the groove until the molten metal fills the space between the cast iron and the so-called clamp. The cast iron and steel merge together.

As the weld proceeds another clamp is applied as before and this is also filled in. The work of welding the seam then is the process of applying the clamps progressively until the end of the seam is reached. These welds are advocated only for such situations as require vertical or overhead seam work. The clamps are used in place of carbon blocks and being fused into the weld slightly reinforce it. Their purpose is not reinforcement, however, but merely to furnish support for the molten metal.

Forms Exhibit Company

L. R. Duffield, formerly general manager of the International Exposition of Industries, Grand Central Palace, New York, and previously manager of the Philadelphia Bourse for a number of years, has formed a new exhibiting company to be known as the Manufacturers' Exposition Co., and has taken a long-term lease on two complete floors of the building at Sixth avenue between Eighteenth and Nineteenth streets, New York, known as the Greenhut building. The company will devote itself entirely to the management and development of permanent exhibitions to occupy the space under lease, which totals over 200,000 square feet of floor space. Special attention will be given to machinery and mechanical appliances. Mr. Duffield is president and general manager of the new company and has associated with him men similarly trained in permanent exhibition work.



THE DOORS OF THE CABINET MAY BE OPENED FOR INSPECTION AND ADJUSTMENT WHEN THE DOORS ARE CLOSED IT IS IMPOSSIBLE FOR THE OPERATOR TO COME INTO CONTACT WITH THE LIVE PARTS

Crane Cage Has Safety Features

The safety cage shown in the accompanying illustration has been developed by the Pawling & Harnischfeger Co., Milwaukee to be used in connection with its extensive line of traveling cranes.

The crane operator can by no chance come into contact with live parts. Even the main knife switch is operated from the exterior of the cabinet by a handle near the top of the right hand door. As will be noted in the illustration, opening the hinged doors exposes all parts for inspection and adjustment. The rear-of-board wiring is accessible by removal of an enclosing panel at the rear.

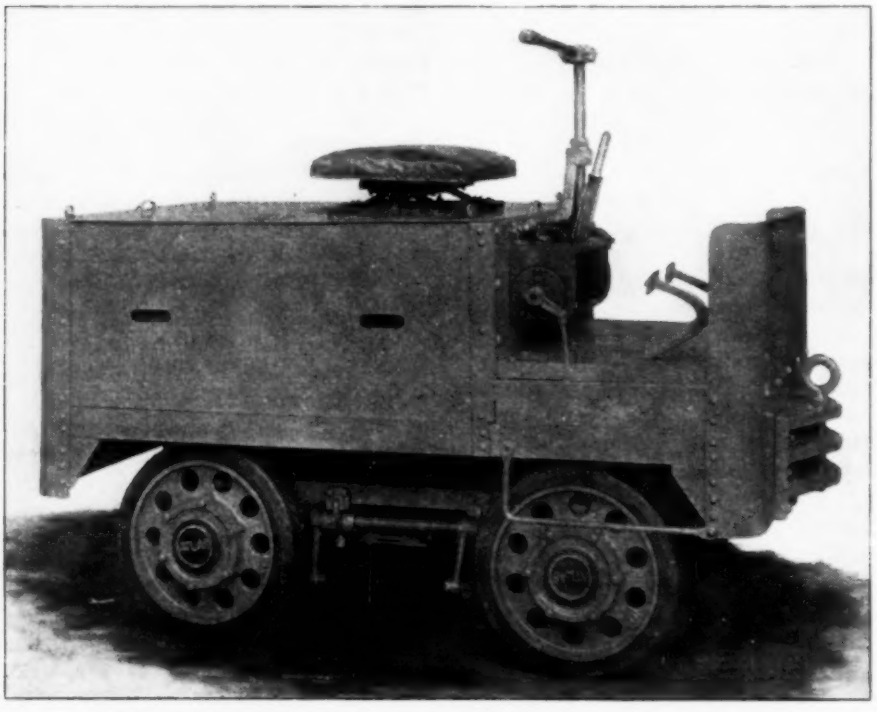
Formerly this company's crane cages were provided with false bottoms in the cab designed to house the resistors. This feature is retained in the new style cage and in addition by providing front lever control and by placing the entire controller equipment and current carrying parts in an enclosure maximum safety is assured.

The levers which operate radially backward and forward are placed at the front of the cage thus affording the operator an unobstructed view. He can see the position and movement of the crane hook, the signals of the floor man, and the entire floor as the crane travels along the runway.

Builds Battery Truck

A new electric storage battery tractor for industrial use has just been added to the line of storage battery trucks and tractors made by the Atlas Car & Mfg. Co., Cleveland. The manufacturer has made a specialty of standardizing parts and has carried out the program to such an extent that all driving, steering, control and trailing units of the various tractors and trucks have been made identical and interchangeable. One of the new tractors is shown in the accompanying illustration. It is 84 inches long, 40 inches wide, has an outside turning radius of 75 inches and has a two-step coupler giving heights of 19 and 22 inches from the floor.

Either two or four-wheel drive is standard. A flexibly coupled vehicle type motor drives a single reduction worm and gear, the latter being entirely inclosed and immersed in an oil bath. The controller is of the drum type inclosed and has three speeds in either direction, the first only being through resistance. Interlocking devices are provided between the controller and the brake to prevent improper operation.



THIS TRACTOR WEIGHING LESS THAN 2 TONS HAS A SPEED UNLOADED ON A LEVEL FLOOR OF 6 MILES PER HOUR

Purchase Only for Immediate Need

Foundries Are Replacing Some Equipment and Buying Small Lots of Essential Machinery—Expansion and New Plant Construction at Low Point

WHILE little business is arising from new plant construction a slight increase is noted in the sales of foundry equipment for replacement. Further, some foundries are making needed revisions in operating practice and are buying machinery which will give lower production costs in the period of keen competition which is approaching. Some foreign inquiry is developing and shipments are being made to Japan, Spain, England and Australia. Improved operation in automotive lines continues to supply some demand for molding machines, while increased orders to jobbing foundries have brought about a better inquiry from this class of castings shops.

Little Activity in the East

NOTWITHSTANDING that prices on most standard foundry equipment are being offered by some sellers at almost 1914 levels, little improvement is noted in demand. Dullness in demand for castings in conjunction with continued labor difficulties in this district is keeping foundries from making additions, and there are few new foundry projects actually getting under way. A couple, however, probably will result in substantial business in the near future. One is a new foundry to be erected by the National Hoisting Engine Co., Harrison, N. J., and the other is a gray iron foundry to be built by the Fords' Foundry Co., Perth Amboy, N. J. This latter company was recently organized with a capital of $50,000, and is headed by Alexander Balint, 175 Smith street. A 1-story building, 70 x 162 feet and 30 x 50 feet, will be erected and ready for occupancy by early summer. Although foreign inquiry continues in evidence—particularly from England, it stops short of actual business. The latest development in connection with export demand is the receipt of some inquiries from Australia for equipment for foundries contemplated to specialize in railroad work. While buying is inactive, sellers look for a revival which, when it sets in, will be of substantial volume. Engineering firms specializing in foundry construction report numerous projects in prospect. Sanitary bathroom fixtures will be manufactured by the All-In-One Co., Marsh-Strong building, Los Angeles, which was recently incorporated with a capital stock of $1,000,000. The company has purchased a site of 10 acres on which it will erect a plant consisting of eight units, including a pattern shop, 50 x 200 feet, and a foundry, 200 x 200 feet. It is estimated that approximately $360,000 of equipment and machinery will be installed. Officers of the company are: President, E. A. Vermere; vice president, J. C. Peterson and secretary and treasurer, Edgar E. Wiker.

Better Tone to Cleveland Market

WHILE only a slight increase has been noted in the volume of sales during the past two weeks, manufacturers of foundry equipment are more optimistic. Ladles, flasks and lighter foundry sundries are more in demand, while a few inquiries for cranes are in the market. The Foundry Equipment Co., Cleveland recently shipped a battery of six drawer-type ovens to Japan for the Kuri Naval Arsenal. The same company also recently sold a battery of ovens to the National Radiator Co., Ltd., Hull, England. Some manufacturers using castings have returned to the practice of barter, offering and trading finished machines to the foundries and receiving castings in return. The Utility Compressor Co. and the Detroit Torch Co. factory and foundry plants recently have been purchased by the City Pattern Works, 508-510 Congress St., Detroit. The new owners have leased the plants to the former proprietors until August, when improvements will be made and equipment will be installed for the production of wood and metal patterns and other foundry equipment. The Ringleader Mfg. Co., Richmond, Ind., recently has been incorporated with a capital stock of $40,000 to manufacture piston rings. W. J. Doan, H. C. Doan, Thomas Tarkelson, F. D. Bethard, W. N. Johnson, W. W. Keller and C. J. Marson are the incorporators.

Operation Low in Chicago District

THOUGH somewhat better volume of business is being done by foundries in the Chicago district it has not been sufficient to cause much increase of buying in equipment or supplies. Most large foundries are entirely closed or operating at only a small percentage of capacity. Smaller shops are doing better and jobbing foundries are in best position of all, doing some work for manufacturers who find it more economical to hire their castings made than to operate their own foundries at a low rate. Fairbanks, Morse & Co. are completing their new foundry at Beloit, Wis., and are installing new equipment. Five sand mixers have just been shipped by the National Engineering Co., Chicago, for use there, making ten of these machines in this plant. Some molding machine builders are making occasional sales, though not to the usual extent. Capitalized at $100,000, the Keuthan Foundry Co., Middletown, O., recently was incorporated at Columbus, O., and will engage in a general foundry business in Middletown. The company plans to erect a modern brick and steel foundry building, which it expected to be ready for operation about the latter part of the summer. C. C. and L. Keuthan were named as the incorporators of the company.

Pittsburgh Inquiry Spasmodic

THAT foundries will not increase their equipment installation programs until they notice an increased demand for their products is the opinion of foundry equipment sellers in the Pittsburgh district. Spasmodic inquiries for core ovens, core-making equipment, electric and annealing furnaces, etc., are received from time to time, but sales are at a low ebb and only urgently needed supplies are being purchased. A few of the inquiries in hand are considered to be feelers only since they give no indication of turning into orders. April was the slowest of several months past as regards sales and the trade has never seen conditions so quiet. Some projects involving molding machines are being considered and tentative proposals are being obtained on different sized machines, all of which is indicative of a coming demand. The Herman Pneumatic Machine Co. is making new installations which

are widely distributed. These include the Dominion Steel Foundries, Hamilton, Ont.; Gibby Bros., Boston; York Mfg. Co., York, Pa.; Warren Foundry & Machine Co., Phillipsburg, Pa.; Beaumont Iron Works, Beaumont, Texas; Oil Well Supply Co., Oil City, Pa., and the Valley Mould & Iron Corp., Sharpsville, Pa. Prospective purchasers of foundry equipment include the East Penn Foundry Co., Macungie, Pa.; The Bovaire & Seyfang Mfg. Co., Bradford, Pa., and the Jersey Shore Mine Car Co., Jersey Shore, Pa., each of which plans early expansion in a minor way. Installation of three electric brass melting furnaces, all of different size and capacity, but built upon the same principle, recently was effected by the Electric Furnace Co., Alliance, O. One furnace, with 500 pounds hearth capacity, was installed at the plant of the Bagley & Sewall Co., Watertown, N. Y., another with 800 pounds capacity was placed in the plant of the Alliance Brass & Bronze Co., Alliance, O., and one with 1500 pounds capacity was installed at the plant of the Empire Brass Works, London, Ont.

What the Foundries Are Doing

Activities of the Iron, Steel and Brass Shops

The Monarch Pattern Works, Detroit, has purchased a site and is stated to contemplate the erection of new shop facilities.

The Fords Foundry Co., Perth Amboy, N. J., has acquired a site for the construction of a new plant.

George Lawrence, Cambridge, Mass., is preparing to erect a 90 x 90-foot foundry and garage building.

Gilbert & Barker Mfg. Co., Georgetown, Conn., plan to construct a 1-story annealing plant, 50 x 100 feet.

Plainville Casting Co., Plainville, Conn., which was incorporated recently, has awarded a contract for a 1-story 70 x 160-foot foundry.

Boyce Hardware Co., Wellsville, N. Y., has been incorporated with a capitalization of $100,000 by C. I. and R. C. Boyce and P. F. Bixby.

The Torsion Test Piston Ring Corp., Cranford, N. J., has been incorporated with $100,000 capitalization by Robert B. Watson, Robert D. Elder, 410 Prospect avenue, and others.

The Bierwith Pattern Works, 51 W. Hancock street, Detroit, plans to construct a new 1-story building, 40 x 100 feet, at Marysville, Mich.

The Atwater Hardware Co., Atwater, Cal., has been organized by B. D. Garlick, A. I. Redrugues, D. Steinberg, J. M. Trinidad, W. E. Landram and Chester Hall.

The Wilmington Brass Foundry, Wilmington, Cal., has been organized to manufacture brass and bronze products. The incorporators are F. J. Breen, R. J. Coan and others.

The Novelty Brass Works, 840 South Los Angeles street, Los Angeles, has been organized by Louis N. Auguer, 1542 W. Fifty-fourth street.

The California Foundries, Inc., Oakland, Cal., has been incorporated by William S. Lorimer, 1418 Hampell street, James F. Hamilton and A. H. Schimmelpfennig.

Canada Iron Foundries, Ltd., Fort William, Ont., is contemplating the construction of a wheelmaking plant as a subsidiary of its present factory. The estimated cost is $150,000.

James P. Sutter Steel Structural Iron Foundry, New Orleans, recently was severely damaged by fire.

East Penn Foundry Co., Macungie, Pa., is said to be planning the erection of a new addition.

The Automotive Foundry Co., Freeland, Pa., contemplates the construction of plant additions and the installation of new equipment.

Springfield Bronze Co., Springfield, Mass., has been incorporated with a capital stock of $50,000. Joseph R. Gould, Leonard Johnston and Robert S. Kneeland, Longmeadow, Mass., are among the incorporators.

Waltham Motors Corp. of Canada, Ltd. Toronto, has been incorporated with a capitalization of $1,000,000 by the following provisional directors: Morley C. Van der Voort, Thomas J. Gallivan and Edward L. O'Reilly.

The Happy Thought Foundry Co., Ltd., Brantford, Ont., recently has been incorporated with a capital stock of $500,000 by John McClary, William M. Gartshore, John McGuinn and others.

The Smarts Brockville Furnaces, Ltd., Brockville, Ont., has been incorporated with capitalization of $100,000 to manufacture furnaces, stoves, etc. James Arnold, John H. A. Briggs, David R. Fowler and others are interested.

Corundo Steel Co., Ltd., Montreal, Que., has purchased the plant of the Record Foundry & Machine Co., 17 Mill street. The new owners plan to establish a factory for the manufacture of cutting and pneumatic tools.

Calumet Malleable Iron Co., 9651 Torrence avenue, Chicago, has been incorporated with a $50,000 capitalization by Francis Meal, M. J. Boyle, George R. Baker, Thomas E. Duffy, Timothy J. Fell and others.

The Exchange Foundry Co., Chelsea, Mass., has been incorporated for $10,000 by Max Winograd, president; Nathaniel P. Sears, 1137 Hyde Park, treasurer, and Helen L. Goodman.

The Holland System Motor Co. has been incorporated with $250,000 capital to build motor vehicles and machinery. The incorporators are D. B. Holland and John F. Holland, Brookline, Mass., and others.

Bickford-Switzer Co., Inc., Greenfield, Mass., has been organized with a capital of $25,000 to manufacture machinery, small tools and implements. Bernard M. Switzer, Greenfield, is treasurer.

Atlas Die-Casting Co., Inc., Worcester, Mass., has been organized with a capital of $100,000. The directors are Arthur M. Brewster, president; Malcolm F. MacNeil, 25 Brighton avenue, Boston, treasurer, and Allan Robinson.

Midway Foundry & Machine Co., Burlington, N. C., plans a plant addition, 40 x 100 feet.

Camden Iron & Brass Works, Camden, S. C., contemplates the construction of a new foundry to manufacture sash weights and nonferrous castings. The company is headed by C. C. Shaw, Columbia, S. C., and W. P. Connelly, Charlotte, N. C.

Glenn Motors, Ltd., Toronto, Ont., has been incorporated with a capitalization of $1,000,000 to manufacture motor vehicles and conveyances. Among the incorporators are Walter B. Kingsmill, Stanley S. Mills and Vincent W. Price, Toronto.

Mayer-Chalmers, Ltd., Sault Ste. Marie, Ont., has been incorporated with a capitalization of $75,000 to manufacture automobiles, trucks, tractors and farm machinery. The directors are William H. Ewing, Walter C. Meyer and William Chalmers, all of Sault Ste. Marie.

A group of eight buildings will be erected on a 10-acre site recently procured by the All-In-One Co., 504 Marsh building, Los Angeles, Cal. The structures will include a pattern shop of 50 x 200 feet, a foundry 50 x 200 feet, a 3-story enameling building, an assembling building, warehouse, office building and welfare rooms.

Maryland Car Wheel Co., Curtis avenue, Curtis Bay, Baltimore, has been incorporated with capitalization of $1,000,000 to succeed the Maryland Car Wheel Works. Plans are being prepared for the erection of additions to cost in excess of $500,000, including equipment. The incorporators of the new company are Samuel M. MacMillian, Raymond M. Berry and Donald H. Sherwood.

New Trade Publications

ELECTRIC FURNACES—The Electric Furnace Co., Alliance, O., is circulating a 68-page booklet in which actual installations of electric furnaces in brass foundries in the United States and foreign countries are illustrated.

CRANE CAGE—Pawling & Harnischfeger Co., Milwaukee, is circulating a small leaflet in which a crane cage with front lever operated controllers is described and illustrated. This cage has the controllers operated by means of a lever stand, placed close to the front of the cage, giving the operator an unobstructed view of operations below. Controllers are mounted in a steel cabinet and the switchboard is mounted directly above the controllers enclosed in a similar steel cabinet. Other details are given.

CRANES—A high speed portable, flexible crane for mounting on any foundation is described and illustrated in a small booklet being circulated by the Universal Crane Co., Cleveland. This crane is a complete unit operated by its own gasoline or electric motor, and is said to have all the functions of larger types of locomotive cranes. Only one man is required to operate it. It has a capacity of from 3 to 4 tons, depending on counterweight furnished, length of boom used, mounting and radius at which crane is working. Other data are given.